A new series—The A-B-C of Oxy-Acetylene Welding
By L. B. Mackenzie

The Welding Engineer

Reg. U. S. Pat Office

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Why Manufacturers Demanding Quality Welds and Speed

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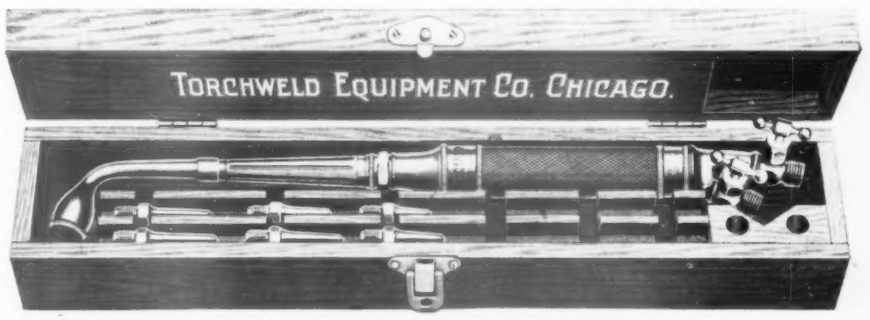

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P. F. Willis

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The Imperial Brass Mfg. Co.
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K-G Welding & Cutting Co.
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Page Steel & Wire Co.
Steel Sales Corp.
Torchweld Equipment Co.

ALPHABETICAL INDEX TO ADVERTISERS

A
Air Reduction Sales Co. 9
Anti-Borax Compound Co. 49
The Arcwell Corporation 15
Atlas Foundry Co. 9

B
The Bastian-Blessing Co. 26-27
Bermo Supply Co. 50
Bierman-Everett Fdy. Co. 3
Buffalo Dental Mfg. Co. 9
Burdett Oxygen Co. 20

C
Canada Carbide Sales Co. 43
Chicago Eye Shield Co. 8
Chicago Welding Compound Co. 24
Commercial Acetylene Supply Co. ..Back Cover
Cortland Welding Compound Co. 17

D
Davis-Bournonville Co. 5
Dayton Display Fixture & Novelty Co. 17

F
F. D. Farnam & Co. 12

G
General Electric Co. 10
General Welding & Equipment Co. 37
Geist Mfg. Co. 11

H
The Harris Calorific Co. 3
Henderson-Willis Welding & Cutting Co. 42
Hauck Mfg. Co. 2

I
Ideal Face Shield Co. 50
Imperial Brass Mfg. Co. 47
International Oxygen Co. 43

K
K-G Welding & Cutting Co. 3

L
L. Lawrence Co. 45
The Lincoln Electric Co. 16
Linde Air Products Co. 22

M
Messer Mfg. Co. 50
Metal & Thermit Corp. 19
The Alexander Milburn Co. 3
Morey Flux & Chemical Co. 50
Modern Engineering Co. 49

N
National Carbon Co. 10
National Gauge Eqpt. Co. 1

O
Oxweld Acetylene Co. 1

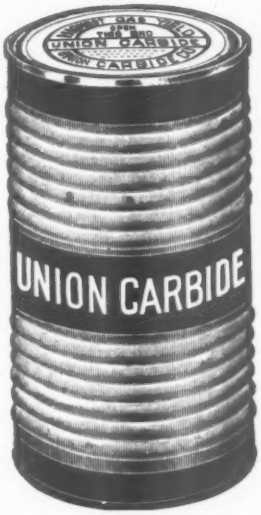
P
Page Steel & Wire Co. 1

S
Smith's Inventions, Inc. 1
Superior Oxy-Acetylene Machine Co. 1
Swift & Co. 4
Steel Sales Corporation 1
C. Sorensen 1

T
The Thermalene Co. 1
Torchweld Equipment Co. ..... Front Cover

U
Union Carbide Sales Co. 1
United States Welding Co. 1
Universal Oxygen Co. 1
U. S. Gauge Co. 1

W
P. F. Willis 1
The Arcwell Corporation. 1



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Virginia—413 Chestnut St.

MISSISSIPPI
Vicksburg—1312 Washington St.

MISSOURI
Kansas City—1316-1318 W. Eighth St.
St. Joseph—920 S. Sixth St., Sta. "A."
St. Louis—(See East St. Louis, Ill.)

NEBRASKA
Omaha—1007-9-11 Jones St., Union Sta. P. O.

NEW JERSEY
Camden—West and Clinton Sts.
Jersey City—554-56 Henderson St.

NEW YORK
Albany—Montgomery and Colonie Sts.
Binghamton—21 Jarvis St.
Geneva—Exchange St. and Railroad Pl.
Jamaica—11 New York Ave.
Kingston—O'Neil St., near Broadway.
Niagara Falls.
Poughkeepsie—Smith St. and N. Y., N. H. & H. R. R. Tracks.
Roscoe.
Utica—135 Hotel St.
Watertown—138 Court St.
Whitehall—22 Main St.

NORTH CAROLINA
Wilmington—Room 16 Masonic Temple, 13 N. Front St.

NORTH DAKOTA
Fargo—17 Broadway.

OHIO
Cincinnati—63-65 Plum St.
Cleveland—601 The Citizens' Building.
Columbus—330 Dublin Ave.
Dayton—812-828 E. First St.
Lima—338 East High St.
Toledo—414 S. Erie St.
Zanesville—Main and Second Sts.

OKLAHOMA
Oklahoma City—27-29 E. Grand Ave.

OREGON
Portland—Fifteenth and Hoyt Sts.

PENNSYLVANIA
Beaver.
Du Bois—Weber Ave. and Franklin St.
Erie—1426 Chestnut St.
E. Greensburg—Clark and George St.
Harrisburg—25 S. Tenth St.
Johnstown—129 Jackson St.
Pittsburgh—1202 Chamber of Commerce Building.
Pottsville—Railroad and Sanderson Sts.
Scranton—Penn Ave. and Vine St.
Shamokin—5th and Walnut Sts.
Williamsport—Canal and Court Sts.

SOUTH CAROLINA
Charleston—153 Church St.

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Chattanooga—627 Volunteer State Ins. Bldg.
Knoxville—426 West Depot Ave.
Memphis—671 South Main St.
Nashville—105-107-109 Broadway.

TEXAS
Dallas—802-810 Cadiz St.
El Paso—900 E. Overland St.
Houston—Baker and Cedar Sts., Box 745.
San Antonio—Cor. Leal and N. Salado Sts.
Waco—13th and Mary Sts.

UTAH
Salt Lake City—118 W. Second South St.

VIRGINIA
Lynchburg—1324 Commerce St.
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Richmond—13th and Cary Sts.

WEST VIRGINIA
Bluefield—195 Roanoke St.
Charleston—Broad St. and K. & M. R. R.
Fairmont—"A" Street.
Huntington—820 3rd Avenue.

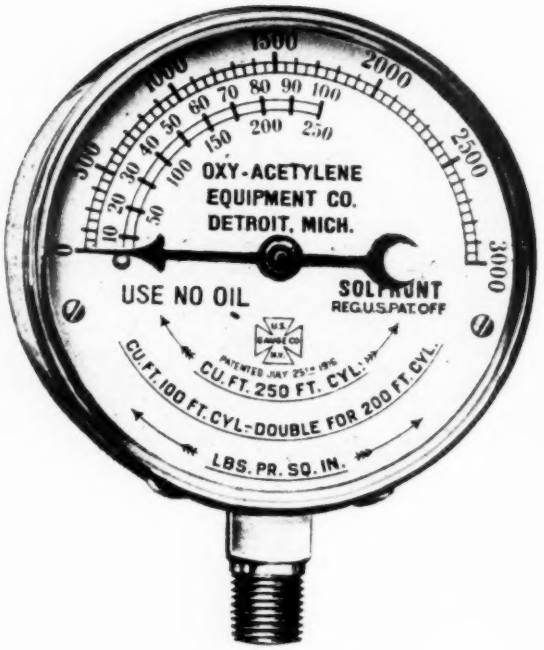
WASHINGTON
Seattle—1103 First Ave.
Spokane—616 Peyton Building.

WISCONSIN
La Crosse—Front and King Streets.
Madison—513-19 Williamson Street.
Milwaukee—120-134 Jefferson St.

We recommend our customers to select from the list, the city from which the quickest delivery and lowest freight rate can be obtained, and address their orders to "Union Carbide Sales Company" at the distributing point selected accompanied by remittance.

Please address request for information or special correspondence to either the New York or Chicago office.

SAFETY FIRST



Patented July, 1916

OXY-ACETYLENE GAUGES

for

WELDING and CUTTING APPARATUS

United States Gauge Co.

67 Wall St., New York

WORKS:

Sellersville, Pa.

BRANCHES:

Clark St. Bridge
Chicago, Ill.

42 W. Larned St.
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681 Market Street
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Fyber-Weld

Goggles for Welders

fitted, when desired, with "Essentialite" Lenses

Frame is made entirely of vulcanized fibre, and in addition to being light in weight is a non-conductor of heat and electricity, is non-inflammable and infusible, is not affected by moisture or perspiration and is easily sterilized and kept sanitary. Has flexible leather center, ventilated side pieces and adjustable elastic headband.

No. 510. With "Essentialite" lenses. Per pair..**$3.00**
No. 510. With plain, clear lenses. Per pair.... **2.50**
No. 510. With amber, smoked, green or cobalt blue lenses. Per pair..... **2.50**
Extra cover glasses, per pair..... **.10**

"ESSENTIALITE" LENSES

To those of our patrons who are not thoroughly conversant with the real qualities and benefits of **"Essentialite"** lenses, we take pleasure in furnishing the following information. In placing the **"Essentialite"** before the trade, we have, after years of experimenting and research, succeeded in discovering the means of protecting the delicate organism of sight against the destructive Ultra Violet rays. We have demonstrated conclusively that with these lenses we vanquish the so-called "fatigue-weariness" and headaches caused by Ultra Violet and Infra Red rays.

The word **"Essentialite"** will become universally the synonym and adjective of a certain grade and color which has the peculiar quality to eliminate the above mentioned troubles. The special green-amber tint will accomplish everything that is claimed for it. While becoming famous for its beneficial qualities under the name **"Essentialite,"** we notice certain goggle makers and dealers endeavor to individualize, and claim to control as their own product, certain imitations. We, therefore, advise our patrons when ordering to please specify **"Essentialite"** lenses, the exact glass for oxy-acetylene welding.

Manufactured by

Chicago Eye-Shield Co.

2300 Warren Ave., Chicago, Ill.

Universal All-Steel Welding Truck

A time-saver and convenience which no progressive welding shop can afford to be without. Made in two sizes; to carry two 100 ft. drums, and to carry two 200 ft. drums.

Truck is equipped with torch hooks on which the torch can be conveniently placed when not in use, and a ten hole tip rack. The welding rod supply box is made to carry eight pounds of welding rods. The supply case, spaced off into compartments, will carry two one-pound cans of flux, cutting tips, adaptors, goggles and wrenches.

The truck has a hand wheel drum tightening device, strongly constructed, and so made that the drums are held tightly, eliminating any shaking when the truck is in motion.

The entire truck is constructed of heavy angle iron, and has a 10 gauge steel platform It is so constructed that when fully loaded it will balance easily, facilitating rapid transportation. WRITE FOR PRICES TODAY

UNIVERSAL OXYGEN COMPANY : Sheboygan, Wisconsin

Milwaukee Branch, 554-556 E. Water St.

High Silicon Cast Iron Welding Rods

Atlas Quality

Also rods, wires and fluxes for welding all metals. Quality guaranteed.

Prices Cheerfully Quoted.

ATLAS FOUNDRY CO.
IRVINGTON, N. J.

Attention, Gas Manufacturers

We manufacture cutting equipment for the following gases:

Acetylene, Carbo-Hydrogen, Hydrogen, Thermoline, Artificial, Rock gas and Natural gas.

Also, Welding equipment.

With your name plate attached if desired.

Our factory is the best equipped in the country for quantity orders.

No goods retailed.

Harris Calorific Co.
2828 Washington Ave. CLEVELAND, OHIO
Send for circular

There's Profit in a Good Welding Outfit

The better the tool, the better the work.
The better the work, the greater the demand for it.
The greater the demand, the more volume and the more profit.

VULCAN

Oxy-Acetylene Cutting and Welding Outfit

is the most efficient. No job too big or too small. No outfit is so economical, so reliable—it cannot be surpassed.

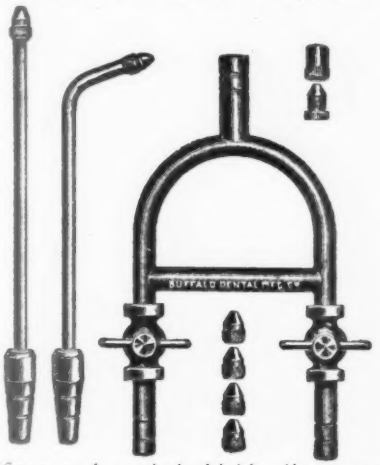
A Vulcan Outfit will be highly profitable for you. But be sure you get a Vulcan.

Send for full information. Ask for catalog W-1.

Air Reduction Sales Co.
2445 University Ave., S. E.
Minneapolis, Minn., U. S. A.

FOR LEAD BURNING

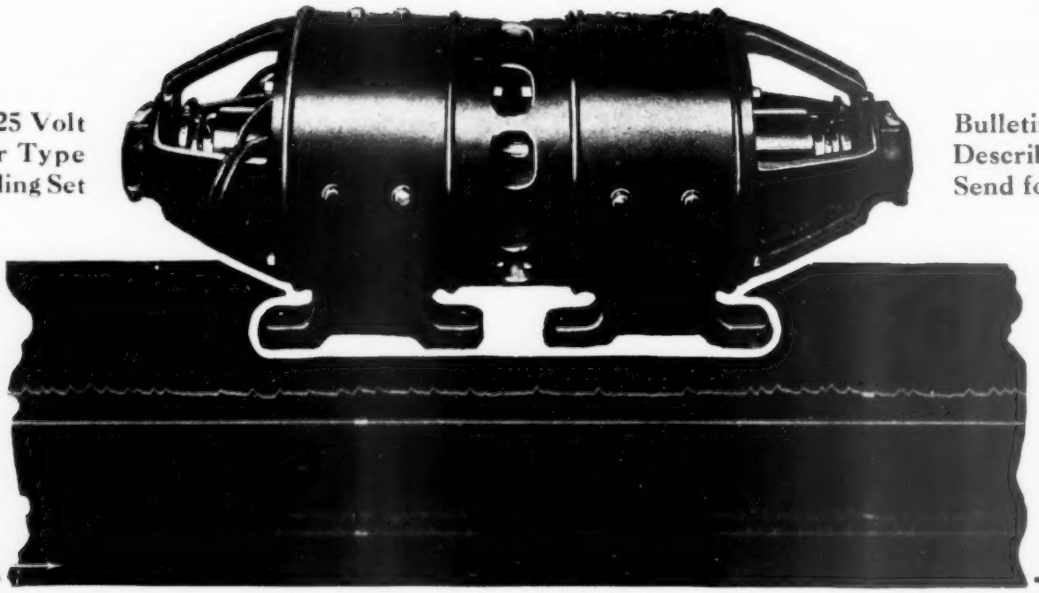
Our No. 28 Oxy-Hydrogen Lead Burner is most complete. Equipped with taps that are ground to a seat, making them easy to manipulate—safety gauzes in the throat of the yoke to prevent accident by a flashing back of flame—a series of jet tips with varying



sized orifices, and a wind shield adjustment to permit its use in draughty places. A straight and curved burner shaft that will meet every possible condition. Price, complete with 5 feet rubber connecting tubing, $7.00. Ask for catalog "B. X.," illustrating and describing this and all our chemical laboratory apparatus.

Buffalo Dental Mfg. Company
Buffalo, N. Y., U. S. A.

3 K.W. 125 Volt
Balancer Type
Arc Welding Set



Bulletin No. 48940
Describes This Set.
Send for it.

Oscillograph curve, showing electrical conditions in welding circuit of constant energy arc welding equipment. Curve "A" shows current in arc, approximate average value 150 amps. Curve "B" shows voltage across arc, approximate average value 15 volts.

Steady Flow of Metal Assured by Efficient and Simple G-E Welders

G-E constant energy arc welding sets are used to assure a steady flow of metal into the weld and high operating efficiency.

A constant flow of metal is assured by the inherent automatic regulation of the energy in the welding circuit throughout the welding range for metal electrodes.

The distribution of welding current between the two units comprising the set and practically dispensing with external resistance in series with arc, assure high efficiency.

One small panel and the set illustrated are all the equipment needed for a one man outfit where operator has mask and electrode with flexible cable—if 125 volt direct current is available.

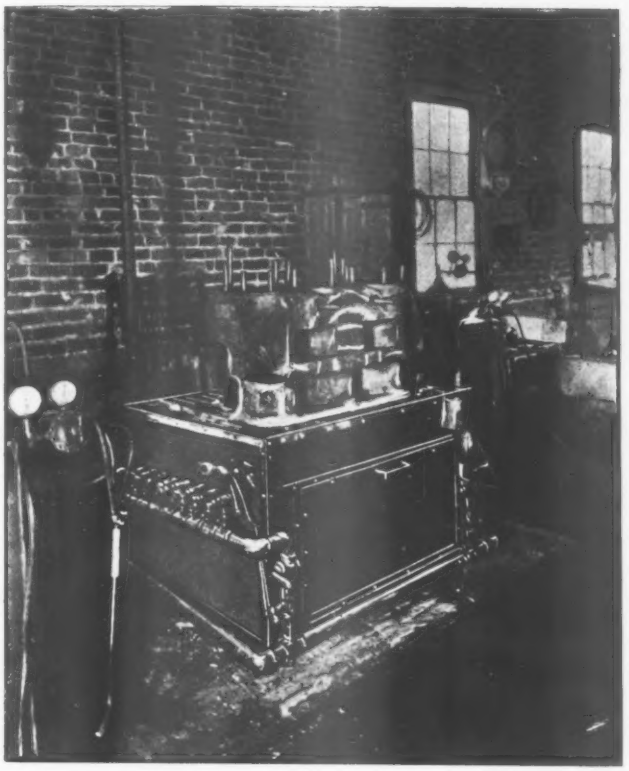
Consistently perfect welds are being produced in essential war industries by the use of this equipment.

We are prepared to demonstrate these sets and make good deliveries.

General Electric Company

General Office Schenectady, N.Y.

A 53½ Hour Job Finished in 5½ Hours



White Chalk Marks in Picture Show the Cracks Welded.

90% Time Saved
75% Fuel Saved

Are you a welder? Then these figures must strike you as startling. Now add to them the fact that no crackage occurred, and that no sand or asbestos or other cooling agency was used. Nor did any charcoal clutter up the shop, and poison the workers with its acrid fumes.

The Wiederwax Preheater

advertising can only be based on cold, hard facts because you welders are all practical men. What is more, we, the Geist Manufacturing Company, prefer to be asked for cold facts, for the colder the fact, the more it emphasizes the remarkable efficiency of The Wiederwax Preheater. At first welders were inclined to be sceptical. That was natural. It was a brand new machine with no record. NOW—within a year's time—the WIEDERWAX PREHEATER has built for itself, on actual performance, the reputation of being an incomparable preheating medium. Glance over the appended table and see why.

COMPARATIVE TABLE FROM ACTUAL WORK DONE

NOTE: The man who did this job did not know before-hand that his work was to be used as an actual example. The job was done under everyday conditions, with no attempt at speed or special arrangement.

With the Wiederwax Preheater

The Job—Harris Marine Engine 45 h.p. 3 cylinders, 7½" bore. Size 37"x15"x20".
No. of Welds—Five.
Time to Preheat—One hour.
Time to Weld—One and one-half hours.
Time to Cool—Three hours.
Cost of Preheating—750 cubic feet of gas at $1.00 per M., 75c.
Total—5½ hours.
Fuel Cost, 75c.

With Charcoal (and "Burying")

The Job—Harris Marine Engine 45 h.p. 3 cylinders, 7½" bore. Size 37"x15"x20".
No. of Welds—Five.
Time to Preheat—Three hours.
Time to Weld—One and one-half hours.
Time to Cool—Forty-eight hours.
Cost of Preheating—$3.00.
Total—52½ hours.
Fuel Cost, $3.00.

In addition to these remarkable figures, there is the fact that there was no danger of fractures with the WIEDERWAX PREHEATER because of its cooling oven. The risk by the "burying process" is always imminent, and it entails a preparation of materials which the Wiederwax Preheater absolutely does away with.

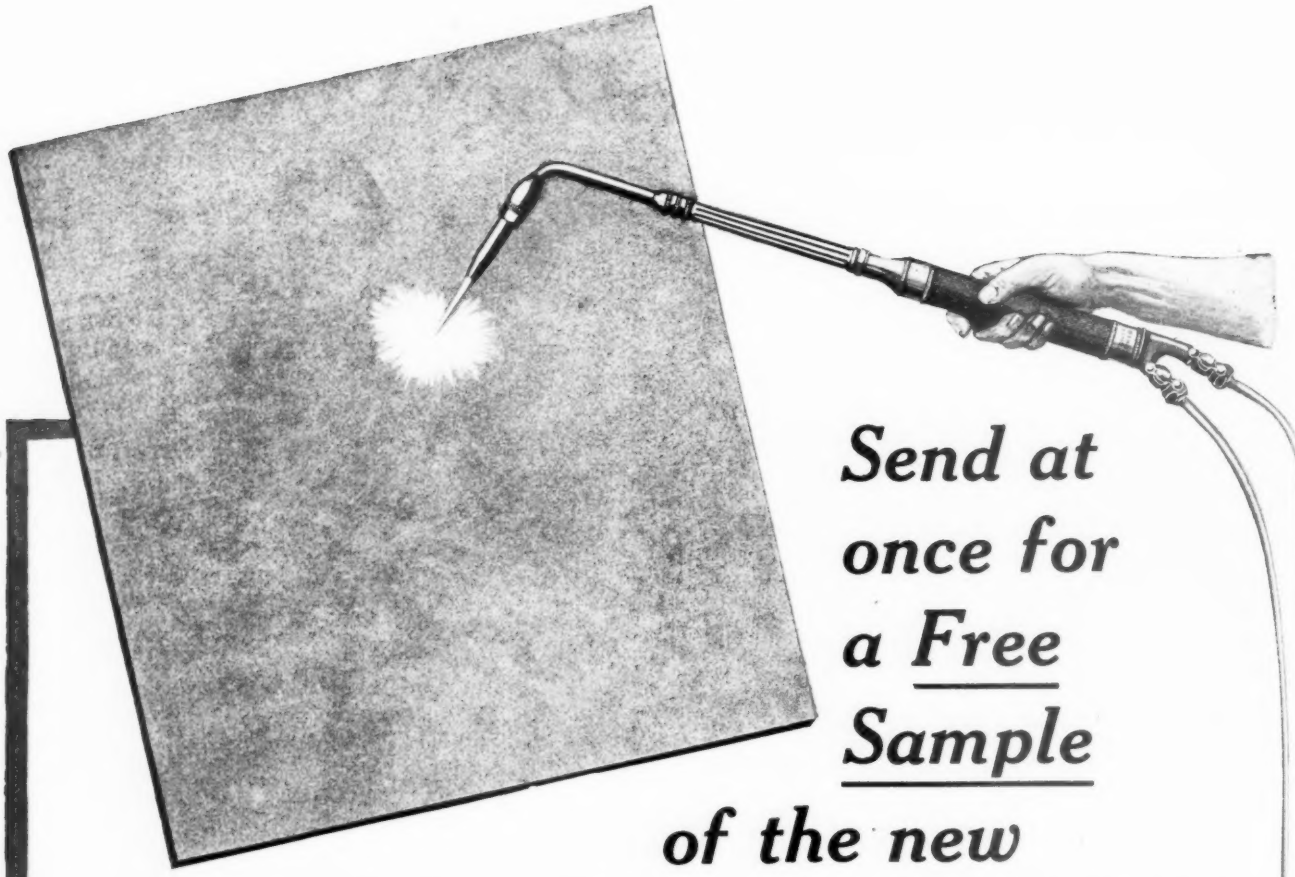
Made in Different Sizes to Suit Any Requirement

WRITE NOW FOR BOOKLET AND PRICES

GEIST MANUFACTURING COMPANY, DEPT. X.
2601 Atlantic Ave.,
Atlantic City, N. J.

Gentlemen—Kindly send me free of charge your booklet on Modern Preheating Methods.

Name .....
Street and No. .....
Town or City. .....State.....



Send at once for a Free Sample of the new

WELDOX

ASBESTOS WELDING PAPER

It's especially made for you — for the welder, not for the casting. Not the ordinary paper manufactured for many uses, but a scientifically prepared, long-fibre, pure asbestos paper developed for one purpose — to furnish a welding paper capable of withstanding hard usage and high temperatures without giving off noxious and injurious smoke, gases and fumes. Your men naturally can do better work when WELDOX Asbestos Welding Paper is used on every welding job.

WELDOX Asbestos Welding Paper comes in 50 lb. and 100 lb. rolls, 36 inches wide.

Test the Free Sample with a torch. Subject it to physical tests. "WELDOX" in your shop and available for every job will save in many ways: It lasts longer; it cuts out eye and lung sore for the welders; it therefore aids in turning out better work in less time.

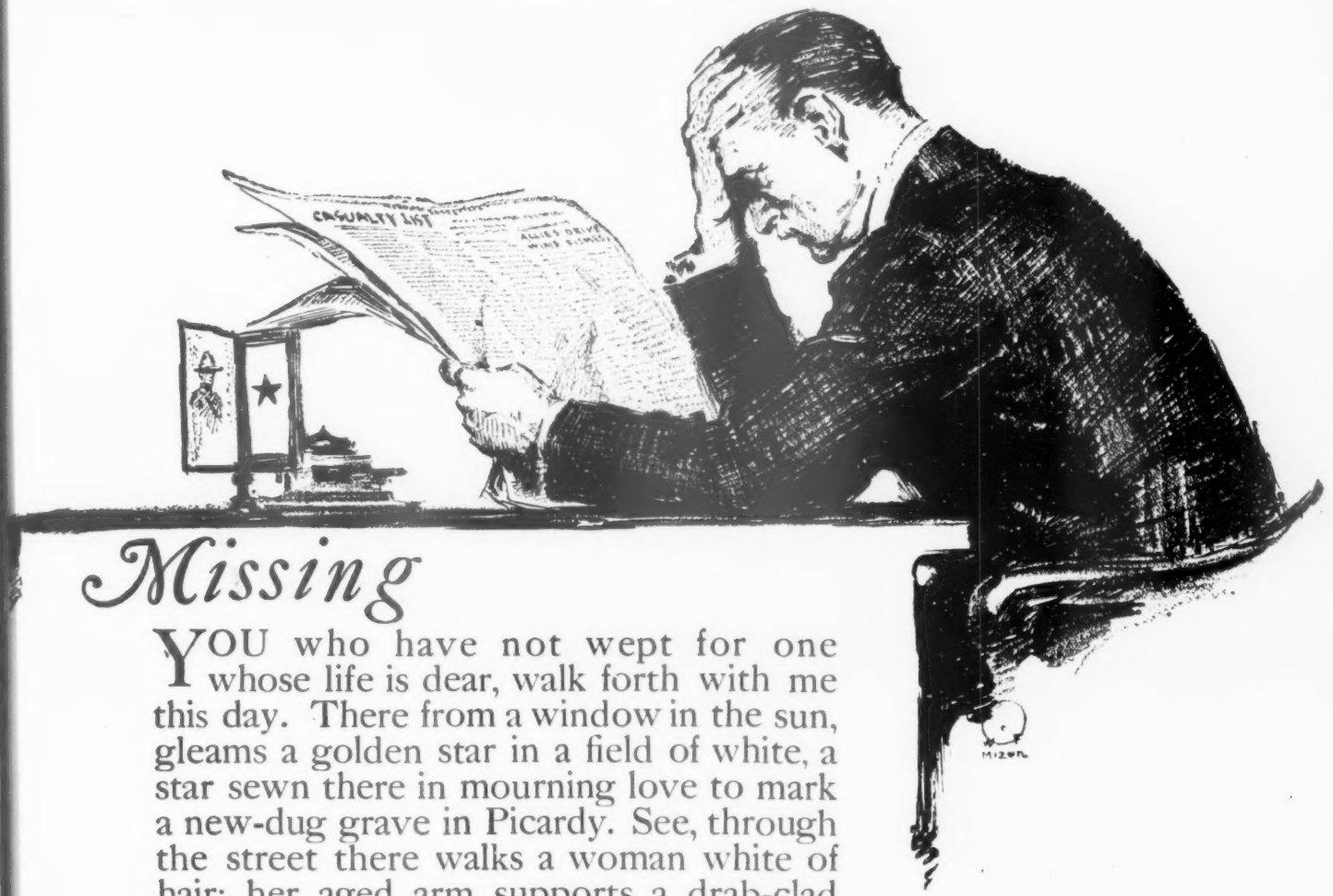
Write for Sample Now

F. D. Farnam & Co.

F. D. FARNAM G. E. HARVELL

140 South Dearborn Street, Chicago, Ill.

Asbestos Mittens, plain.
Asbestos Mittens, reinforced.
Asbestos Mittens, plain, one finger and thumb.
Asbestos Mittens, reinforced, one finger and thumb.
Asbestos Mittens, rivet faced.
Asbestos Mittens, 23-inch length over all.
Asbestos Gloves, 5 fingers.
Asbestos Leggings, 16-in. to 30-in. length.
Asbestos Aprons, made to specifications.
Asbestos Masks.



Missing

YOU who have not wept for one whose life is dear, walk forth with me this day. There from a window in the sun, gleams a golden star in a field of white, a star sewn there in mourning love to mark a new-dug grave in Picardy. See, through the street there walks a woman white of hair; her aged arm supports a drab-clad boy, yet in his teens, as with falt'ring step he gropes his sightless way. At an office desk a man, not different from yourself, sits with bowed head and harshly sobs over the day's newspaper where his prescient finger found his son there listed with the "missing." ¶ You who have not wept for one whose life is dear, give utmost thanks that yours have yet been spared to serve the common cause of right. Give utmost thanks that though you may not walk their fields of death and face the peril you fain would share, that of your bloodless treasure you may make an ally that will speed their cause and yours. The day's duty is that you buy War Savings Stamps; that you affix your name on Pershing's Honor Roll as one who has fulfilled his part. So, buy these stamps today.

SAVE
W.S.S.
WAR SAVINGS STAMPS
ISSUED BY THE
UNITED STATES
GOVERNMENT
SERVE

PERSHING PATRIOT
W.S.S.

Maximum number of $5 War Savings Stamps that may be purchased by one individual during 1918 is two hundred. During August this represents an investment of $838.00. Buy this full allotment if possible—if not, as many as you can. Let the Pershing Badge signify that you have bought to the limit of your power.

War Savings Committee for Illinois, 403 Conway Building

His Land Life-Preserver
The American Gas Mask

WHEN the gas-clouds come rolling in, the American soldier feels safe in the knowledge that *he has the best gas mask worn* by any soldier in any country. Speed in putting the mask on is vital, for as one British General said: "In gas warfare there are two classes—the quick and the dead." Our men are thoroughly drilled, and everyone must be able to put on his mask in *six seconds* or be *left behind* when his unit goes to the front.

There is not a single case on record of an American soldier being gassed through lack of chemical protection in the present type of gas mask. If a man is gassed, it is through accident or delay in not putting his mask on properly.

Worn on the chest, for instant use in time of danger, the mask can be put on with just *five motions* of the arms and hands. It fits over the head like a baseball catcher's mask. A nose-clip closes the nostrils, and insures breathing only through the tube connected with a canister filled with chemicals, which is carried in the bag strapped to the chest. All outgoing air leaves the mask through a flutter-valve near the chin.

A splendid record has been achieved in producing gas masks in the United States, and there is now in France a mask for every member of the American Expeditionary Force, beside ample reserve supplies. This mask combines the wide experience of the English and French with improvements of our own. It is admittedly the best mask on the Western Front, and gives twenty times the protection of the German mask. Over twelve hundred selected men are engaged in supervising production and inspection of the masks. These men wear the masks in gas-filled test houses, experimenting on *themselves* before asking others to try new features.

With good discipline and thorough drill, the men soon become accustomed to wearing the masks and have served batteries under hurricane fire for periods of twelve hours without taking them off. Ball games have been played with masks on, as a stunt.

This page is prepared with the aid of the Gas Defense Division, Chemical Warfare Service, so that the American public may have positive knowledge of how adequately our men at the front are protected against gas attacks. The folks at home should not fail to urge their boys to "go strong on the gas drill."

COMMITTEE ON PUBLIC INFORMATION, 8 *Jackson Place, Washington, D. C.*

George Creel, *Chairman* The Secretary of State The Secretary of War The Secretary of the Navy

Contributed through Division of Advertising U. S. Govt. Committee on Public Information

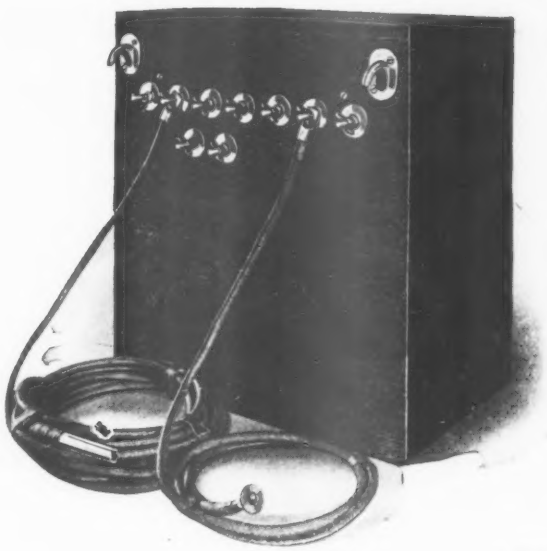
This space contributed for the Winning of the War by
THE WELDING ENGINEER

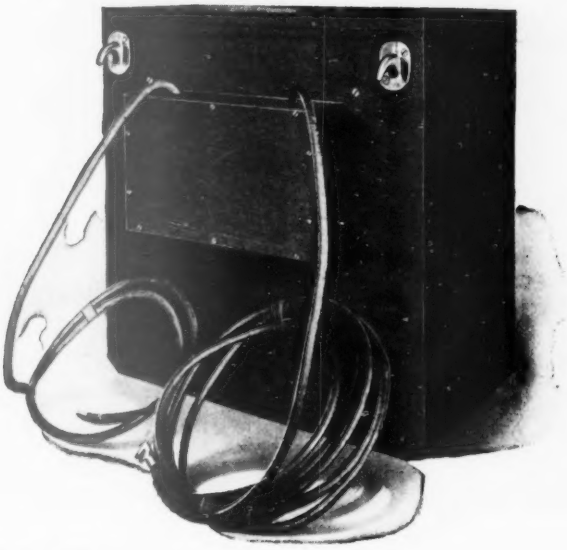
Announcement

of

The Mephisto Welder

Alternating Current Arc Welding and Cutting Machine





LOW FIRST COST

No Motor Generator Set
Weight 300 lbs.
Size 26"x27"x18".

Air Cooled.
No External Resistances.
No Moving Parts.

Efficiency over 90%.
Power Consumption (4 k.w.)
No Regulating Panels Required.

Machines built for either 220-440 or 550 volt a.c. circuit of any frequency.

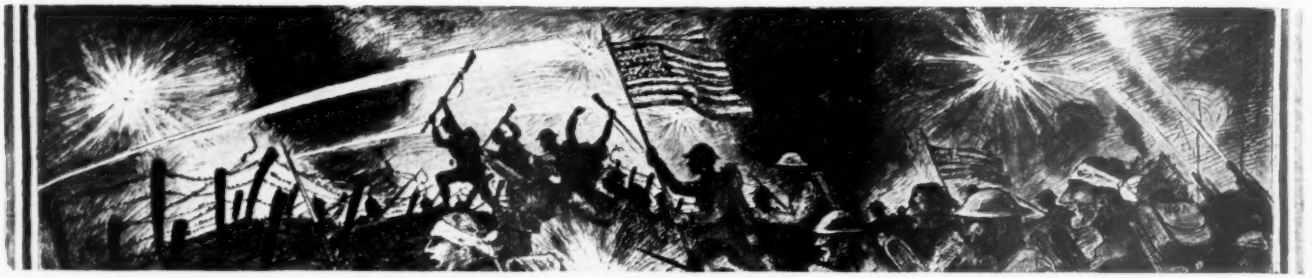
Machines can be supplied in any size in multiples of 75 amperes.

IMMEDIATE DELIVERY OF STANDARD 150 AMP. MACHINES

We offer the services of our engineering department without charge on special welding problems.

The Arcwell Corporation

42 Broadway **New York City**

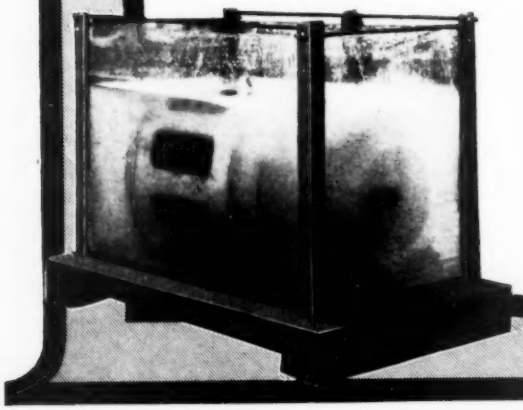


LIBERTY LOAN

Decide how much you will invest in Fourth Liberty Loan.

Give five minutes sober thought to what our splendid boys in France have done—are doing—and will do.

Double your intended subscription.



This Lincoln Motor operated under water over 3 years without damage to windings.

The Lincoln Electric Co.

Cleveland, Ohio

New York City	Chicago	Philadelphia
Buffalo	Detroit	Charlotte, N. C.
Syracuse	Columbus	Toronto
Boston	Pittsburgh	Montreal
	Minneapolis	

Agencies in other principal cities.

WELD TRADE A MARK CAST

Stands Alone

For Efficiency As An Oxy-Acetylene Welding Flux

Write for Free Samples
and Be Convinced

CORTLAND WELDING COMPOUND CO.
CORTLAND, N. Y.

Welding Pincers

Use up the short pieces of Welding Metal

This pincer enables the welder to use up his strips of metal almost to the end, all the time keeping his hand a good distance from the heat.

The handle is always cool, no matter how short is the piece of welding metal.

The time saved in welding the strips together quickly pays for the pincers.

Pressing the spring handle releases the jaws to pick up the metal. Length of pincers, 19 inches. Holds rods of 3-16-inch to ½-inch diameter.

Price $1.00

One sent to the address of any Welding shop for 30 days' trial, on receipt of $1.00. If not satisfied money will be refunded on return of pincers.

Jobbers and Agents, write

C. SORENSEN

18 E. 16th St. **CHICAGO**

Swift Oxygen

For Welding and Cutting

Unsurpassed for Quality

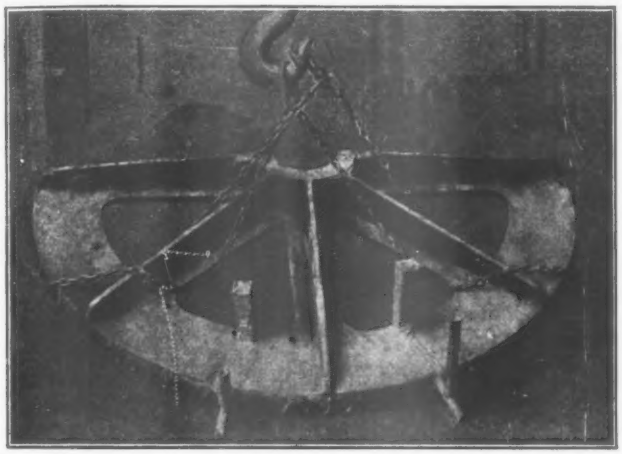
Pure Oxygen Electrolytically Made under the direct supervision of our Chemical Laboratory. It is carefully controlled by chemical analysis, thus insuring the highest obtainable purity.

We carry a large stock on hand so can fill orders immediately.

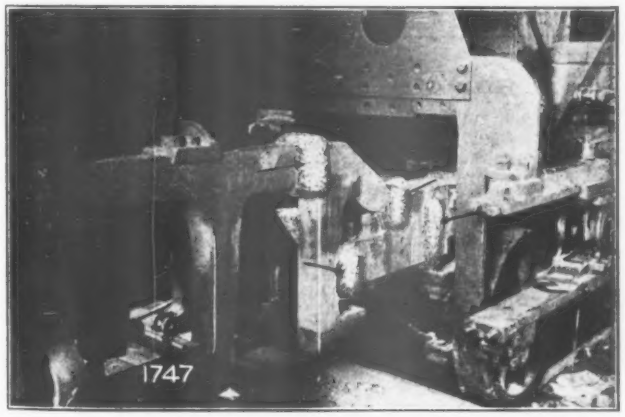
Swift & Company

Oxygen Department **Union Stock Yards, Chicago, Ill.**

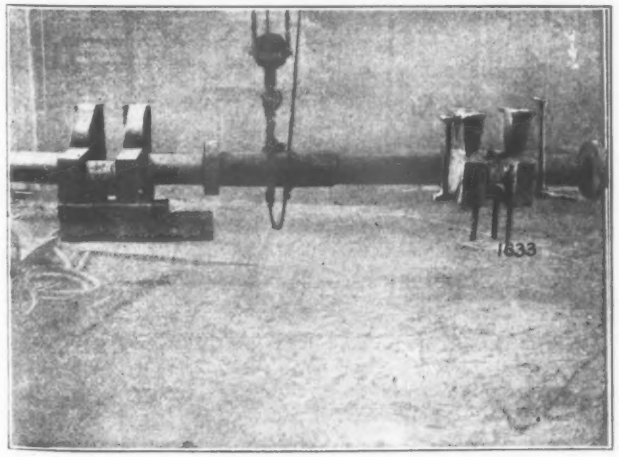
New neck cast on to large roll made with the aid of Thermit and having the pods cast in at the same time.



Large bevel gear on which two new teeth and crack have been repaired.



Four Thermit welds on locomotive frame on the Missouri Pacific Railroad, made without removing the frame from place.



New crank pin welded in by the Thermit Process.

THERMIT

The Only Reliable Process for Welding Heavy Sections

THIS Explains Why Railroads and Steel Mills Used Over One Million Pounds of Thermit in 1917. Also Why 95% of the Railroads in the United States and Canada Having Over 10 Locomotives, Use Thermit for Welding Frames and All Heavy Sections.

There are few machine parts which are subjected to greater strains or more severe shocks than a locomotive frame or a blooming mill pinion. Yet Thermit welds on such parts are being made every day and STAND UP IN SERVICE FOR YEARS. The reason for this is that, unlike ANY OTHER WELDING PROCESS, the steel to make a Thermit weld is produced IN BULK at a temperature of 5000° F. Furthermore, results are not dependent on the individual skill of the operator.

We have ample proof for all our claims and our long list of satisfied customers who come back week after week, month after month, and year after year for MORE THERMIT is a never ending testimonial to the efficiency of the Thermit Process.

Remember that Thermit should not be confused with either oxy-acetylene or electric welding. It stands in a class by itself. It welds sections which cannot be successfully welded by any other method.

Let us tell you more about it. Write for pamphlet No. 1779.

* * * *

Metal and Thermit Corporation

(Successors to Goldschmidt Detinning and Goldschmidt Thermit Co.)

The Equitable Building
120 Broadway, New York

7300 So. Chicago Ave., Chicago
329-333 Folsom St., San Francisco
1427 Western Ave., Pittsburgh
15 Emily St. W., Toronto, Ont.

BURDETT OXYGEN COMPANY

AND ASSOCIATED COMPANIES

ELECTROLYTIC OXYGEN and HYDROGEN - 99 1/2 % Pure

Service from the following BURDETT PLANTS

Seattle, Wash.
Los Angeles, Cal.
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Salt Lake City, Utah
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Fort Worth, Texas
St. Louis, Mo.
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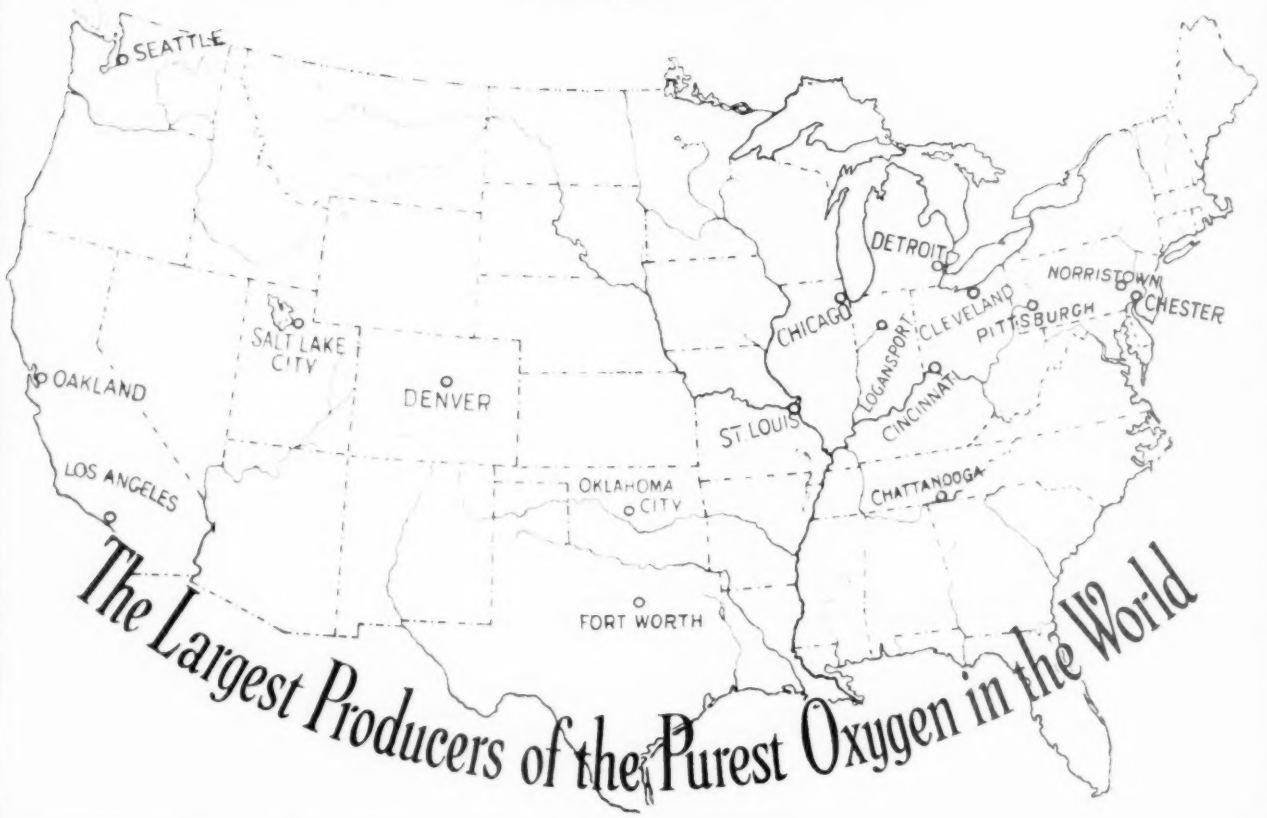
Chester, Pa.
Norristown, Pa.
Cleveland, Ohio
Chicago, Illinois



The Largest Producers of the Purest Oxygen in the World

2 lb. cans, $3.00 per can

2 lb. cans, $1.00 per can

AN Aluminum break when melted does not flow together as other metals do, but the edges creep away from each other. There is a film on the surface, dull grey in color. This film is **ALUMINUM OXIDE.** It must be destroyed before your weld can be a success. By using **RED DIAMOND** Aluminum Welding Flux the aluminum oxide is instantly destroyed and the metal assumes a bright silvery appearance. By adding **RED DIAMOND** Flux with the hot welding rod, in the usual way, not only does the aluminum oxide disappear, but dirt and grease as well.

A trial can of **RED DIAMOND** Aluminum Welding Flux will convince you that this is the flux you have been waiting for. Put up in 2 pound cans, $3.00 per can.

THE best insurance a welder can have that his welds will be sound and free from craters or blow holes is to use a good flux, made scientifically by chemists who understand the needs of the welder.

The object of a cast iron flux, or in fact any flux, is to eliminate the **OXIDE** and other impurities which form on the surface of the weld, caused by the heat and combination with oxygen of the air. The reactions are the same as in a blast furnace or cupola and flux is used to **CARRY OFF THE SLAG.**

BLACK DIAMOND Cast Iron Flux, when dropped on the molten surface of the weld, instantly clears the metal of iron oxide and other foreign substances, leaving a clear, mirror-like surface, which enables the metal to run together. This condition makes a sound weld.

A very small amount of **BLACK DIAMOND** Cast Iron Flux is required to assure a good weld. The price is a secondary consideration—it's the quality that counts. Put up in 2 pound cans, $1.00 per can.

Chicago Welding Compound Co.

Transportation Bldg. **Chicago, Ill.**

Our Service Department is at your service.
Consult us about your flux troubles

SPECIAL NOTICE TO USERS OF OXYGEN

THE requirements for Government work make it imperative that every Linde cylinder be emptied and returned immediately.

Orders should be issued to everyone in your employ having to do with cylinders, emphasizing the importance of this.

Oxygen deliveries under present conditions will be largely regulated by the rapidity with which cylinders are emptied and returned.

THE LINDE AIR PRODUCTS CO.

The Largest Producers of Oxygen in the World

42nd STREET BUILDING

NEW YORK

BUILDING UP VALVE SEATS

By A. Lucas

SOME interesting reclamation work has recently been done by Mr. A. Lucas, which was the declaming of cylinders by building up worn out valve seats through the use of the oxy-acetylene process.

The cylinders are first stripped of all fittings, such as bearings and studs. The valve seats are then cleaned on all sides, so that when welding the operator will have no scale or dirt to contend with, thus preventing hard spots, which generally occur after a weld containing a mixture of scale and dirt with the metal.

We then cut a strip of sheet asbestos ⅛ inch thick, to fit the bore and stroke of the cylinder, as shown in Figures 1 and 2. This is to prevent any scale or damage to the cylinder walls. The asbestos may be held in place by wire rings placed on the inside.

A furnace for preheating, constructed as shown in Figures 2 and 3, is recommended, the heat to be applied as uniformly everywhere as possible, by the four burners. The sub floor is to keep the flame from coming in direct contact with the work. This process will be found advisible in all work, as it prevents oxidation and scale. In this type of furnace a wonderfully uniform heat can be obtained.

Bring the temperature of the furnace to about 1,100° F., then place the cylinder in the furnace on two V blocks, as shown by (A) in Figure 2. This allows the heat to pass all around the work. At the point where the cylinder reaches a dull red heat, which is about 1,050° to 1,150° F., the operator should commence work, leaving the cylinder in the furnace.

Upon the completion of one valve seat, close the furnace door and again bring the cylinder to the same heat as before, then commence on the other valve. When the welding is completed the furnace is again closed and the temperature raised to the same stage as at first. The cylinder is then removed and placed in a lined box to cool gradually, the asbestos lining being removed before it is put in the lime. The cast iron filler rod must be absolutely clean and absolutely free of sand or dust. Three-sixteenths inch is recommended and 3 per cent silicon. The cast iron flux must be of such ingredients that when the welding rod is dipped in it the rod will carry a drop of liquid to the weld.

The welding torch must be of such a type that it will keep cool in any position while welding regardless of heat surrounding it. To fulfill these conditions a water cooled torch must be used.

The torch must be long enough to allow the operator to work comfortably far away from the work. A correctly designed torch of this kind will not back fire, will not cause the neutral flame to become oxidizing, will not cause any delay in the work by having to stop and cool the torch in a bucket of water, but will enable the operator to make a neat and first class welding job, the most essential part being that the job is soft enough to allow a reamer to make a smooth even finish on the new valve seat. The reamer is the only method used for dressing down the seat, therefore, the welding must be done with great care in order to have the metal soft and easy to work.

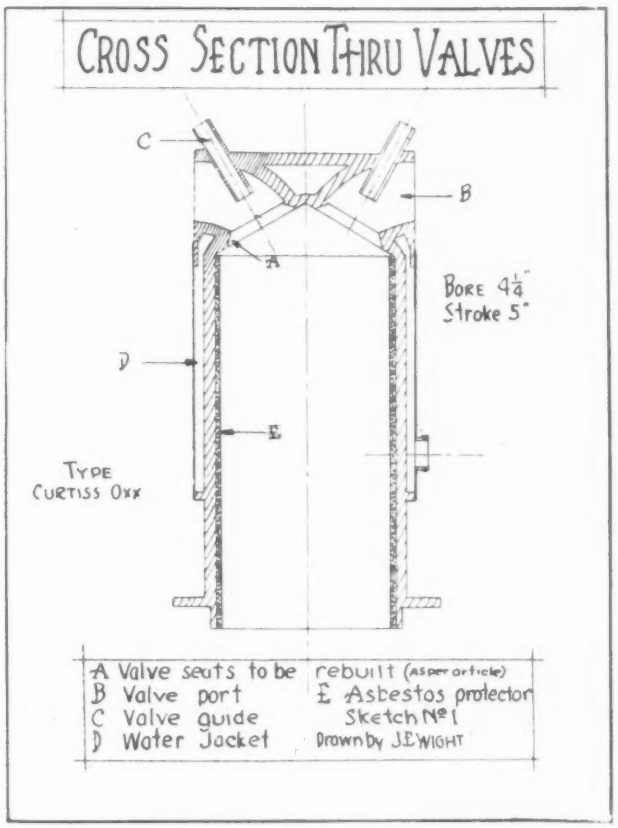


Fig. 1.

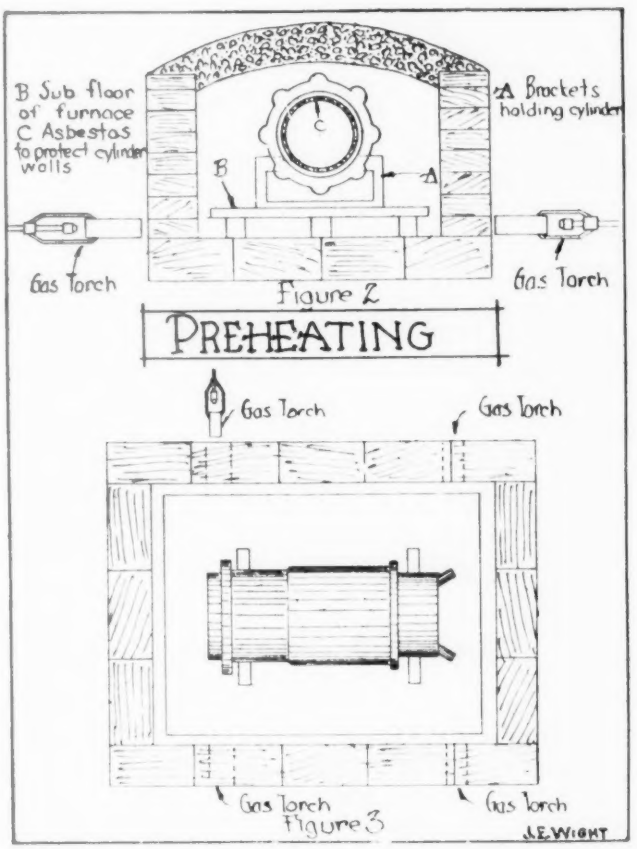


Fig. 2—Fig. 3.

This work is especially adapted to aviation motors, as at the present time the demand is great and new cylinders are hard to secure. In aviation work, valves must always be in perfect condition. This necessitates almost daily grinding and after 150 or 175 hours the valve seats are completely worn out, while if the motor has received proper care, the bore still remains good. By building up the valve seats, the life of the cylinder can be lengthened for from 600 to 800 hours, until the cylinder itself is worn out.

This work should not be attempted by beginners under any conditions, for although it appears simple, it requires a skilled operator with a thorough understanding of the process to perform it successfully. The entire operation, if performed correctly with the proper equipment, should not require more than three hours.

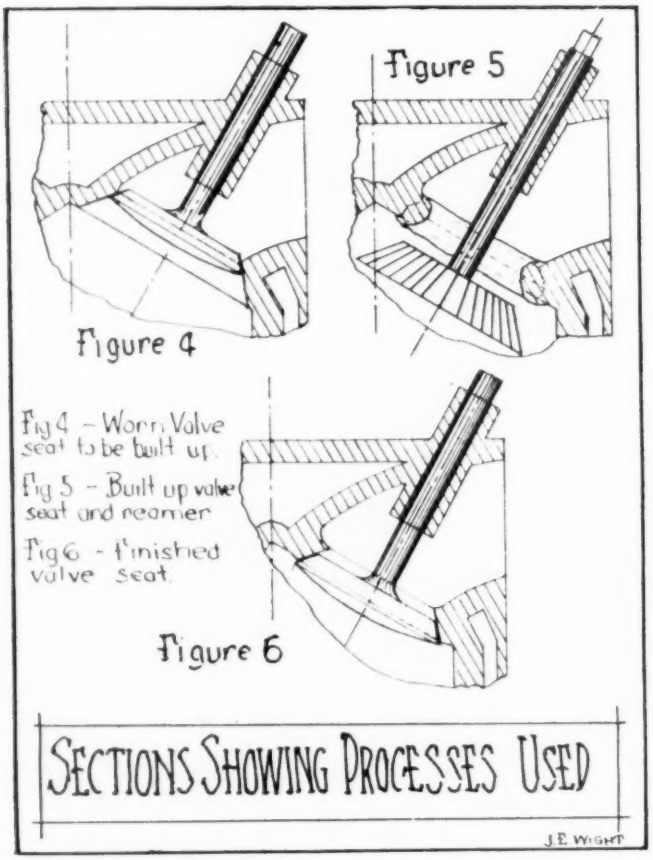


Figure 5
Figure 4
Fig 4 - Worn Valve seat to be built up.
Fig 5 - Built up valve seat and reamer
Fig 6 - Finished valve seat.
Figure 6
SECTIONS SHOWING PROCESSES USED
J.E. WRIGHT

Fig. 4.—Fig. 5.—Fig. 6.

Any additional information can be obtained from Mr. A. Lucas, through Mr. L. B. Mackenzie of *The Welding Engineer*.

Sixty men formerly in the service of the Metal & Thermit Corporation are in service. Captain de Courcy Browne is now in France, attached to the Heavy Artillery. He was formerly Metallurgical Engineer for the Metal & Thermit Corp.

A-B-C of Oxy-Acetylene Welding

By L. B. Mackenzie

The series which starts in this issue may be secured in reprint form, by chapters, at a very low cost.

THE HOLT MANUFACTURING COMPANY

Peoria, Illinois

WELDING JOB COST TAG

Job. No..... For.....
Article .....
Date Started .....
Date Finished .....
Welding Tip No.....Hours.....Min.....
" " " ..... " ..... " .....
" " " ..... " ..... " .....
Oxygen.....cu. ft. Acetylene.....cu. ft.
Preparing, Hours.....Min.....
Welding, " ..... " .....
Finishing " ..... " .....

Rods	Remarks
.....lbs. Steel	.....
.....lb. Cast Iron	.....
.....lbs. Bronze	.....
.....lbs. Aluminum	.....
.....lbs. Charcoal	.....
.....Gal. Oil	.....

Welder .....
Inspected by .....

Cost system installed by us for Holt Co. to show *approximate* cost on each job. As gas is used in manifolds piped throuout. The shop it is necessary to figure gas consumption of various sized tips for time shown. While this varies with each operator the general average is very close and checks up good with total gas used.

WHO AND WHAT IS AN EMPLOYMENT MANAGER?

By C. T. Clayton

Chief, Training and Dilution Service, U. S. Department of Labor.

Especially in the manufacture of aircraft, but to an increasing degree in many other industries concerned with war work, acetylene and electric arc welders are essential, and at the present time, far too few in number. Methods for adequately training new workers are being planned by the Training and Dilution Service of the Government, and manufacturers needing such skilled workers will be assisted by this Service to develop training, both through plant training departments and through the assistance of technical schools organized with the cooperation of the Federal Board for Vocational Education.

One thing, however, should first be done by every manufacturer using welding processes; if he has not already got it, he should put in a complete employment department in his establishment; nothing can do more toward reducing the waste of his present force through turnover. But the manufacturer should be sure that the employment department he puts in is a real employment department, with a chief having independent authority and not merely a hiring clerk. If the employment manager exercises authority delegated directly from the head of the establishment, is able to sit into conference with the managing officers of the organization and to speak with knowledge and authority upon industrial questions, his service to the organization will be invaluable. More and more it is coming to be recognized that just as well-conducted establishments must have experts on organization for production, they should have experts on management of the still more indefinite human elements which we have been calling our labor.

In the old days, when employers worked side by side with their men and knew each one individually, employment managers were hardly necessary because the idiosyncrasies of the

workers, their ambition, and their troubles were familiar to the employer, as he was usually a promoted working man. Today the employer is frequently only a list of stockholders, absentee, residing thousand of miles from the establishment, and knowing the workers only as items of cost upon a ledger. For these organizations the employment manager represents the collective conscience of these share holders. He will see what the workers ought to have; he will know what the workers ought to do; he will give them an understanding of the real purpose of the organization and will get from them a loyalty because of that understanding which no other agency possibly can secure. As a first step in obtaining a sufficient supply of skilled welders in this country, therefore, these plants should seriously take up the question of obtaining the services of a skilled employment manager.

The work of an employment manager includes selection of workers, their placement in the establishment, and promotion, as they show fitness for higher grades of work. Understanding selection of men will go a long way towards avoiding the aggravated situation we now see of so many people being hired only to be released because unsuited. Training undertaken without a sound selection before it and wise placement after people are trained is likely to be disappointing. The Training and Dilution Service, therefore, urges that the establishment of these employment departments go hand in hand with the training which we hope will be given in all war plants. This brings up a very serious question. More than forty thousand firms are now engaged in war work in this country. Two million more are going to the Army between this time and next July. Probably more than six millions will be called upon to engage newly in war work in their support. Where are the employment managers for the forty thousand firms? They must be found, and just as the men must be trained, so they must be taught how to do their work. The practical thing for every manufacturer to do is to select from his own organization a person who seems best adapted by wisdom, energy, tact and vision, and send him—or her, for women, if they have the industrial background, are very well adapted for this purpose—to take training in one of the employment management courses now being carried on in several universities under the auspices of the Employment Section of the War Industries Board. Manufacturers should get in touch with Captain Boyd Fisher, 717 Thirteenth Street, Washington, regarding the details of these employment management courses.

Interior of Army Welding School at Peoria, Ill.

A NEW TYPE OF PORTABLE ARC WELDER

Although electric arc welding has been used for several years in the iron and steel industry its use has mostly been confined to factories, repair shops, and other locations where the work can be brought to the machine.

The accompanying illustration, however, shows a new type of portable arc welder, which presents especially interesting features and is designed for operation where electric current is not available.

It consists of a Lincoln Electric Co. 150 Ampere Arc Welding Generator direct connected to a Winton G. L. 5 gasoline engine and is intended for mounting on an automobile truck or other convenient position so that it may be transferred from place to place.

Although at present The Lincoln Electric Co. is only supplying these sets to the Government for shipbuilding yards and other places where electric arc welding can be used to advantage, on war work, it is probable that as soon as Uncle Sam's requirements are filled there will be a large demand for this type of Arc Welders for oil pipe lines, boiler shops, large steel foundries, dry docks, etc., for advantages of greater speed, lower cost and better results are in most cases decidedly in favor of arc welding as compared with gas welding, brazing or riveting.

An interesting point in the construction of the Lincoln Arc Welding machine is the method adopted to insure a steady arc and a constant and readily controllable heat—the greatest two difficulties met with in the design of this class of apparatus.

The volts required to maintain a welding arc vary from 50 down to as low as 15 volts (where a metal electrode is used.) The plan adopted by most makers to render the arc steady is to introduce sufficient "ballas resistance" in series with the arc to prevent excessive current being taken when the operator short-circuits the generator on "striking the arc."

This method is exceedingly wasteful, more than three-quarters of the power generated being absorbed in the ballast resistance itself.

The Lincoln Arc Welder uses a compound wound generator the series winding of which is connected up so as to oppose the shunt field and the two windings are so proportioned that the voltage decreases in the same ratio as the current increases, thus limiting the short-circuit current. Another important effect of this is that the horse-power and therefore the heat, developed for a given setting of the regulator switch (shown on the control board above the generator) remains practically constant.

It has been proven that a killowatt hour can be made to do four or five times as much work with the Lincoln Welder than with machines using ballast resistance.

Additional arc stability is also insured by the stabilizer (seen at the extreme right of the picture.) This is a highly inductive low resistance coil connected in the welding circuit. It serves to correct momentary fluctuation of current in much the same manner as the flywheel of an engine produces an even turning speed.

REGO WELDING and T

A Money-Making M

THE June issue of this magazine contained the announcement of the REGO line of welding and cutting apparatus.

The details of this announcement created a decided sensation for they described a torch built upon a really new principle, whereby the costly flashback was absolutely eliminated and a material saving in oxygen consumption promised, this lessened oxygen consumption resulting in better welding. In addition it was announced that many mechanical improvements in torch construction had been perfected, and that the price would be reasonable.

Practical welding men were skeptical—they had a right to be—for the flashback had been "eliminated" so often in the minds of the advertising staffs of apparatus manufacturers that men skilled in the art had come to believe that the flashback was a necessary evil and that torch conditions were such that it could not be removed.

REGO apparatus has been five months on the market and in that time, without advertising other than in the columns of THE WELDING ENGINEER, has become a leader. From Coast to Coast and from Canada to the Gulf, the name REGO has become synonymous with the best in welding and cutting apparatus.

"From Coast to Canada

California:

Owners of a large job shop and welding s

"We have tested your torch and compared t the others we use. Your torch is by far the b every way, and we are satisfied that it requ more than a demonstration of what it can d the sale is made."

Massachusetts:

A company which operates four repair sho New England, and which for ten years repres in that territory a competing equipment:

"We received the 3 cutting torches, also large ing torch and tips, and would say that we p large welding torch into use immediately, a connection with this torch would advise tha the best welding torch not only in operation also in construction, that the writer has seen."

Five months ago, it was necessary to t our word for the claims we made. N you have opportunity of learning w men who know the welding and cutt game think about this new and wond ful apparatus.

We didn't ask for these letters; nor for t many, many others from practically States. They were written because th men couldn't help writing them and each case were accompanied with ord for additional apparatus.

THE BASTIAN-BLESSING

TTING APPARATUS

lage to Welding Men

past and From he Gulf

ario, Canada:

man who for many years has been a practical elder and who owns a large shop in Toronto:

We have given torches an exhaustive trial and n pleased to inform you that they are the best e have ever handled, and we feel confident that r orders will increase in the near future, to our utual satisfaction."

isiana:

company which maintains one of the largest pair shops in the South:

We have made every test that we know to make d put it to two days' hard usage in our shop, and ill only say that any comment would be a waste space, as you know the results."

GO apparatus is being made and sold in uantities. One user, after purchasing cutting torch for trial, installed over ne hundred. Many of the largest in-ustrial concerns in the country are users f REGO equipment.

sell very little apparatus direct to the ser—we prefer not to; so we make a iberal proposition to the man or com-any who stocks and sells REGO equip-nent.

It isn't necessary to make a very heavy investment in stock, for this Company has on hand equipment in quantities permitting us to ship within a few days of receipt of order from our jobber—in many cases we are able to ship the day the order is received.

The largest electrolytic oxygen plants in the country handle REGO apparatus; some of the most successful branch managers of competing companies have started agencies of their own to sell REGO; successful job welding shops in many cases have added salesmen to their force when they have demonstrated in their own plant the money making possibilities of selling REGO apparatus in their territory. Some smaller apparatus manufacturers have discontinued the construction of their apparatus in order to sell REGO.

There are huge possibilities for successful men in selling the complete line of REGO equipment made by this company. We have an interesting proposition for the right kind of men. If you know how to sell oxy-acetylene apparatus, want to get into business for yourself, and can carry a small stock of equipment, write us or come to Chicago to learn our plans.

To the User:
The torch handled and endorsed by the big jobbers and dealers is pre-eminently the torch to use in all industries and in the job welding shop.

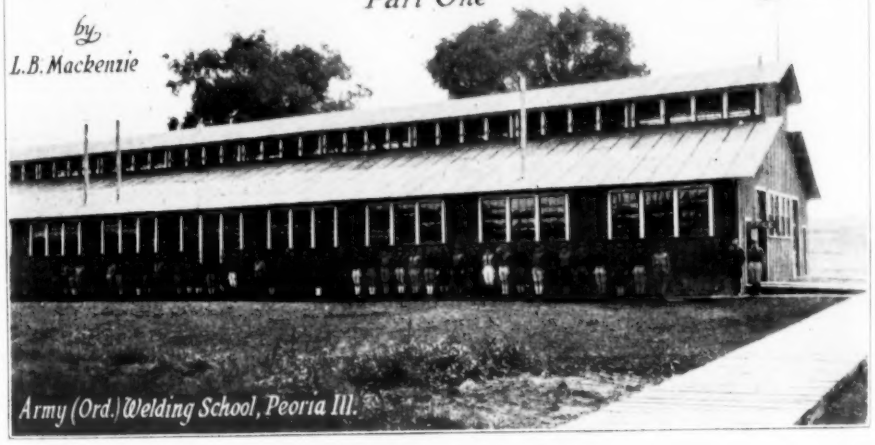
Send for a copy of the new booklet "A new principle in Welding and Cutting Apparatus."

OMPANY W. AUSTIN AVE., AT LA SALLE STREET, CHICAGO

A·B·C of Oxy-Acetylene Welding

Part One

by L.B. Mackenzie



CHAPTER I—CAST IRON.

Fully sixty-five per cent of the work the welder is called on to do is related to cast iron, directly or indirectly. This was true, at least, up until the time the production of munitions (1918) assumed such proportions in the United States. Therefore, the first chapter of this series is devoted to our most serious problem —cast iron welding.

If it is true that the majority of our welding problems relate to cast iron, so it is true that these problems center about the question of preheating. Most all cast iron objects, upon which the welder is required to exercise his skill, are usually of a peculiar shape, requiring skill in the understanding of and regulation of expansion and contraction.

Upon the welder's appreciation of these problems depends his success or failure as a welder.

The physical properties of cast iron may be said to consist of density, elasticity, strength, toughness, brittleness and chill. These may all differ in having characteristic qualities in different brands or classes of cast iron. The first essential or element upon which cast iron is graded is "grain," or the degree of density. No. 1 cast iron, so graded by the trade, is as close-grained as a piece of glass, and is usually termed "white iron." It is grey in color, has a dark, open grain, and melts at 1,150° Centigrade. When sound, cast iron stretches but very little, possibly about .00018, or one part in 5.555 of its length; or ⅛ inch in 57.9 feet for every ton of tensile strength per square inch up to its elastic limit, which is about one-half its break strength.

Castings are designed to resist transverse, tensile, crushing, and impact blows or strains. For this reason, transvere tests are he forms of testing, mainly used to obtain knowledge of the strength of cas iron. Therefore, do not depend upon castings to *stretch*.

Carbon is to be found in all castings, in different states. In castings made from "white iron," the carbon is *dissolved* in the iron so the casting is very hard.

In a grey iron casting the carbon is contained in what is termed a *free state*, in the form of graphite. When the line of the weld is hard, brittle and glass-like, and hard to machine, the carbon content is in a free state. When the weld is soft and easy to machine the carbon content is in the form of graphite.

Frequently we are asked how to overcome hard spots in cast iron welds; welds which are difficult to machine or file. This trouble is usually due to one or more of three causes; first, poor flux, which has a tendency to dissolve carbon, and which does not carry off the impurities properly; secondly, a poor welding rod, which does not contain a sufficient quantity of silicon, which is a softening element; third, too rapid cooling of the weld, which permits the carbon to dissolve rapidly, hardening the metal. Cast iron welds should cool slowly. Each time cast iron is melted the metal becomes harder; therefore, the weld which is brought to the fusion state quickly will usually be found to be soft and machinable. If the welder constantly melts and remelts various parts of the weld, because the flame is being manipulated improperly, the weld will probably contain not only hard spots, but craters, or blow holes. When it is necessary to reweld a cast iron seam it is advisable to remove all of the first metal added and the old metal melted, to guard against hard or brittle spots and craters.

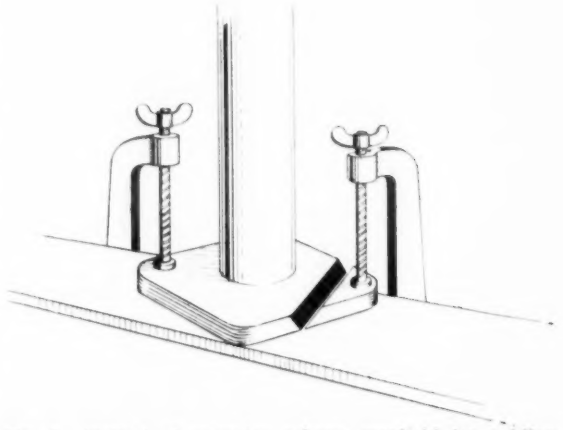


Fig. 5. Method of preparing exhaust manifold for welding.

The welder is usually responsible for the chemical quality of the weld.

Quite frequently the welder is required to distinguish btween malleable and cast iron.

Malleable is a species of cast iron which has been subjected to a heat treating process. It is more ductile than cast iron and will bend before it breaks. Malleable castings have a skin, like an orange. When subjected to a hammer blow a malleable casting will dent, where an ordinary gray casting would break. Malleable castings are tough and will melt more like steel on the outside; as the action of the flame continues and the outer shell of the castings is melted away craters, or holes, will appear, which differ from an ordinary casting.

A malleable casting also presents a smoother surface than an ordinary casting. This is because no trace of sand is left in a malleable casting, while sand marks almost always are visible in ordinary castings.

A piece which is broken and which shows a short fracture, the broken parts of which fit well together, shows cast iron. Malleable iron is tough and before the breaking point is reached there is elongation, and consequently the edges of the fracture are more jagged. Malleable castings are discussed in the following chapter.

Most all metals will expand a certain amount when heated, and thus expanded,

upon castings to *stretch*.

Carbon is to be found in all castings, in different states. In castings made from "white iron," the carbon is *dissolved* in the iron so the casting is very hard.

Most all metals will expand a certain amount when heated, and

they will contract when cooling. Therefore, in such subjects as gear wheels, fly wheels, cylinders, etc., unless provision is made for expansion and contraction before welding, trouble will result. We have known of cases where a broken spoke in a fly wheel has been successfully welded without preheating any part of the fly wheel, but, nevertheless, an internal strain existed in the wheel, a strain which is sure to cause trouble for some one.

Beveling

A consideration, however, which comes before preheating, is the question of proper beveling and preparation of the piece to be welded. To some the matter of beveling may seem of secondary importance, but a series of tests recently conducted by *The Welding Engineer*, in connection with the welding of pieces of tank steel, developed the fact that a great many welds were apparently spoiled by insufficient preparation.

The young welder is apt to judge a weld by its outward, or surface appearance. Nothing could possibly be more deceptive than the outward appearance of a weld of any sort. Therefore, the importance of proper beveling and fusing, *beginning at the bottom of the V*, should be impressed on the beginners mind.

Castings should, before welding, be carefully freed from dirt, grease and rust, so far as the welding line is concerned. Cracks in pieces more than

Top Fig. 1. Note beveling does not penetrate entire thickness to be welded, about ⅛ inch being left.
Bottom Fig. 2. Beveling from both sides in section of cast iron over one inch in thickness. Note section in middle not beveled.

⅜ inch in thickness should always be beveled before welding at least to a 90° angle. When beveling cast iron pieces it is not necessary that the V should penetrate through the entire thickness of the metal. Up to one inch it will be found best to leave about ⅛ inch of the thickness unbeveled, as shown in Fig. 1.

When the metal to be welded is over one inch in thickness, and it is possible to weld from both sides, it will be best to bevel from both sides, as shown in Fig. 2.

The general tendency of welders is to sacrifice thoroughness for time, therefore, many welders will be found to be "flowing" or melting out the metal on the line of the weld. This is usually bad practice and unless done by a very skillful operator is almost sure to result in after trouble.

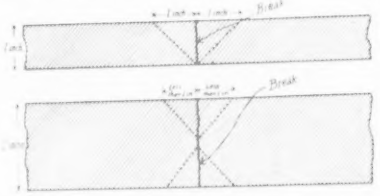
The operator is apt to oxidize or burn the metal, and the line of the weld is apt to contain craters, or blow holes. The cost of the gas used is also a great factor and more than likely to equal the labor involved in proper beveling, provided proper tools are used.

The novice will usually raise the question as to why any cast iron object should be beveled and welded from both sides. If this were not done with thick picees, it would be necessary to greatly increase the angle of the bevel; otherwise it would be exceedingly hard to reach the bottom of the [illegible] the flame without first meeting the sides and top. When the bevel is not sufficient the molten metal will flow over the bottom and, not being properly fused, will cause an unreliable weld. It is possible to "dig" into the metal with the flame, but this method is not always successful and is expensive and insecure. Cast iron must not be melted and remelted.

Where the beveling is to be done from one side only, the distance on each side of the fracture should be equal to the thickness of the piece. This is illustrated in Fig. 3.

When the beveling is to be done from both sides, the distance on each side of the fracture should be equal to a little less than one-half of the thickness of the piece. This is illustrated in Fig. 4.

Beveling may be done by either chipping (by hand, electric, or pneumatic power), sawing or grinding. For small objects, no doubt, grinding is quickest and recently portable electric grinding machines have come into general use. They do the work quickly and their first cost is small. For larger castings, involving considerable chipping, pneumatic or electric chisels are time savers. It should be remembered that if broken lugs or flanges are to be welded, the parts are to be lined up carefully. A frequent weld of this kind is an exhaust manifold. The pieces are placed on a flat surface (a piece of tire iron, for instance). The method of clamping is illustrated in Fig. 5.



Top Fig. 3. When beveling is done from one side, same should be started one inch on each side of fracture.
Bottom Fig. 4. Beveling from both sides.

Preheating

As was pointed out at the beginning, preheating, and no doubt "after heating," are probably two of the most important elements entering into the execution of a successful weld. Most all cast iron subjects require preheating, if not from reasons relating to contraction and expansion, then for economy's sake. It is poor business to preheat a large object with expensive oxygen and acetylene gases, when a cheaper means is available. Cast iron objects must not be allowed, after welding, to cool too rapidly.

If the cast iron object to be welded is small, and the problem of contraction and expansion need not be considered, it is well to heat the casting before welding. This will save oxygen and acetylene and will improve the weld. The casting may be heated in several ways, either by the torch, which we do not recommend, or by charcoal or an oil or gas burning torch or furnace. No doubt one of the latter methods is quickest and cheapest. Recently a special oven has been developed for this purpose.

Some welders prefer a charcoal fire for preheating, but we believe this is a matter of training and custom, and not because the charcoal fire is more ef-

ficient. The disagreeable fumes and the matter of loss of time are factors to be considered, to say nothing of the scarcity of charcoal and expense. We much prefer preheating torches or furnaces using city gas or oil.

It should be remembered that the conductitvity of cast iron is very low, therefore, it will stretch only so far as the preheating process extends. Therefore, a mistake may be made by not preheating sufficiently, but no mistake could be made by preheating too much.

When in doubt—*preheat.*

Note—The subject of preheating will be continued in the next issue.

WELDING MALLEABLE CAST IRON

Chapter Two

Many answers have been given to the question "What is Malleable Cast Iron?" Some of the answers have been remarkably vague and in consequence there is a prevailing idea that it is ordinary grey cast iron, which has undergone some special annealing treatment. This is entirely misleading, as malleable iron is really a form of steel, and not, as is sometimes supposed, of wrought iron.

In other words, it is a cast iron of a special composition, from which a certain amount of carbon has been extracted. This sounds very much like a definition of cast steel, and in fact, the two grades of castings have many characteristics in common.

Malleable castings are not "annealed," and the process through which they pass is often misnamed. Annealing can be accomplished by the action of heat only, but when the castings are packed in ore, or any other suitable decarbonizing material, whether the object is precipitation or partial elimination of the carbon content, the process becomes one of conversion.

The real "annealing" of a malleable casting takes place in the "muffle," in the foundry, where the high initial strains are modified. In the subsequent process the heat is only necessary to open out the structure of the casting, so as to allow the oxygen to penetrate and the carbon, which is in the form of dioxide, to escape.

A malleable casting possesses a "skin" like an orange, which results from the so called annealing process. The center of the casting consists of cast iron, the outer skin of what we may treat as wrought iron, and in between the outer "skin" and the core we have an intermingling of the two metals which we might term an "intermediate zone." This is illustrated in Fig. 6.

A malleable casting will bend or stretch before it breaks, something a grey iron casting will not do. When an ordinary grey iron casting is broken the edges of the fracture will fit perfectly, while the break in a malleable casting will fit imperfectly, because the metal has "stretched." The surface of a malleable casting, when struck with a hammer, will dent, a grey iron casting will not dent.

When the flame is applied to a malleable casting the outer shell will melt like steel. If the flame is continued in the same position, the metal will act like cast iron, and if held in position a little longer, blow holes will appear.

Malleable castings should not be welded, but brazed. The fracture should be beveled in the same manner as for welding. If the thickness of the casting warrants, the beveling should be done from both sides.

Small or thin malleable castings, so small in fact that the so called "skin" penetrates entirely through the casting, may, of course, be successfully welded.

Tobin bronze is usually used, although some operators use manganese bronze. The melting point of the latter metal is higher, but the metal is tougher.

All grease should be removed from the vicinity of the fracture, in fact the bevel should be cleaned with kerosene and perhaps brightened with a file.

A larger tip should be used than for the same thickness of cast iron, because a wider zone must be heated, without bringing the metal to the fusion point. The flame should be held farther away from the casting than usual.

Heat the welding, or rather brazing, line to a dull red. Use a good brass or bronze flux and add the flux sparingly with a Tobin rod. Hold the torch from one to three inches away from the surface of the metal, depending on the size of the casting and the tip used. As the casting just passes the dull red color the rod is touched to it. If the rod has been heated before applying to the casting, and the entire casting is hot enough, the bronze will spread rapidly

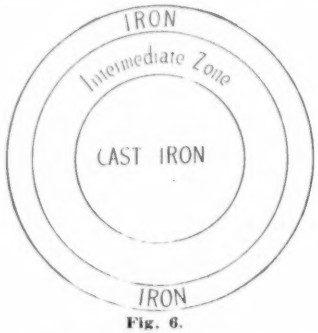


Fig. 6.

when the rod is applied. If the metal remains in globules the line of weld is not sufficiently heated. The torch should be kept at a uniform distance as the operator will be better enabled to control the distribution of the metal.

Some authorities hold that it is not necessary to preheat malleable castings, but this is not true. The laws of contraction and expansion may not be defied, no matter what the metal may be. Liberal preheating was never responsible for failure, and conservative after cooling, slow and cautious, is an insurance.

When it is necessary to braze such parts as pipes or tubes in malleable sockets or dogs on the ends of shafts, and where it is necessary to cause the bronze to flow very freely, an oil burning or gas torch is best. A small fire-brick furnace is built around the object to be welded, in the usual way, and when hot the bronze is run into the opening to be filled, which should be overcharged. In every case, in fact, the welding line should be overcharged.

Because of the high temperature of the oxy-acetylene flame, do not attempt to use it to heat the brazing line. If the heat is not distributed evenly and some part of the line is overheated, the bronze will not adhere to it, will not flow and will roll off. Use the flux sparingly, but with regard to the clean appearance of the flowing bronze.

LECTRIC ARC AND OXY-ACETYLENE WELDING

THREE papers on welding were presented this past summer before the Cleveland Engineering Society. "Electric Arc Welding," by Robert E. Kinkead,* engineer of welding, Lincoln Electric Co., Cleveland; "Oxy-Acetylene Welding and Cutting," by Hugh H. Dyar, Davis-Bournonville Co., Cleveland; and "Electric Butt Welding," by J. B. Clapper, plant engineer, rim and tube division, Standard Parts Co., Cleveland.

Comparing the electric arc and oxy-acetylene processes, Mr. Kinkead stated that with few exceptions the same operations may be accomplished with either the oxy-acetylene or electric arc process. The electric arc has a higher temperature than the oxy-acetylene flame and the great part of its heat is produced in an extremely localized area within the metal to be welded rather than external to it, as is the case in the oxy-acetylene flame. The heat of the arc being produced in the metal is more efficiently used, so that it is possible to do at least three times as much welding with a given amount of heat produced by the electric arc as would be possible with the same amount of heat produced by the gas process.

"The cost of producing a unit of heat for autogenous welding with the present prices of gas and electric power is," said Mr. Kinkead, "about in a ratio of gas, 3; electric, 1. With an 'effectiveness' factor of about 1 to 3 in the use of the two processes, it is evident that the cost of gas is in the neighborhood of nine times the cost of electric power doing the same work.

"Up to the present time the electric arc welding process has been used almost exclusively in the welding of steel," he continued. "The very great localization of heat of the arc gives it a marked advantage over the oxy-acetylene plant for welding on boiler plate and sheet metal. The difficulties arising from expansion and contraction with the attendant buckling of the plate and cracking of the weld encountered in the use of the gas process are, to a certain extent, eliminated in the arc process due to this localization of the heat.

"Gray iron may be welded with the carbor arc welding process, but the operation is somewhat more difficult than welding with the gas flame, and perhaps requires more skill on the part of the operator."

Welding of Cast Iron and Steel

The welding of cast iron, Mr. Kinkead emphasized, is rather a difficult matter, with either process. The difficulty is not due to the welding of cast iron—it can readily be welded—but due to the expansion and contraction strains it may crack, and the weld, if it is not properly cooled, is apt to be hard. In the case of a thin section as an automobile cylinder the weld cannot be handled successfully with the carbon arc, due to the fact that the carbon arc will go through before the weld can be made, whereas with oxy-acetylene the operator can back off and reduce the temperature. Relative to building-up operations, Mr. Kinkead stated that the metal-electrode was used more than the carbon for the reason that the heating for the metal-electrode process is localized.

Various Applications of Electric Welding

One of the most interesting applications of the electric arc welding process, Mr. Kinkead pointed out, is in the locomotive shops and roundhouses of the country. "It is used to weld the flues into the back flue-sheet of the boiler; to weld cracks and patches in the fire-box; to weld in new sections of the flue-sheet, door-sheet or side-sheets; to repair broken frames without dismantling the engine. Worn links, guides, hangers, etc., are built up with new metal, re-machined and put into service in a few hours' time. Worn flanges on the drive wheels are built up without dropping the wheels, and the engine is put in service without turning the tire."

In answer to questions, Mr. Kinkead explained many points of interest that arise in the use of the electric arc. Relative to the welding of dissimilar metals, he stated that the electric process can be used to deposit steel on cast iron and the union between the cast iron and steel is good, that is, it is a fusion; but the difficulty is that the steel and iron are molten at the same instant, with the result that the molten steel absorbs the carbon, and we get high carbon steel on the steel side of the weld, so that there is a line of fusion; one side is steel and the other cast iron. On the cast iron side a small area only of the cast iron is raised to the molten state, which, cooling quickly, becomes hard and brittle, so that on the line of fusion there are two kinds of metal, both of which are very hard and brittle. Such metal is unreliable and will not stand any dynamic stress. Mr. Kinkead furthe rsaid that brass cannot be welded to cast iron because the zinc in the brass volatilizes in the high temperature of the arc, whereas copper and steel can be welded to a perfect joint, as can bronze if it contains no zinc.

Electric Welding of Plates

The subject of the thickness of plates that can be welded was also discussed. Much cannot be done, Mr. Kinkead stated, with metal ⅛ in. thick or less. Where it is too thin, say 1-16 in., and it is desired to weld a straight butt joint, a heavy backing has to be used to carry the heat away, otherwise the heat of the arc will burn through. For 3-16-in. plates no backing is required. Under certain conditions, trouble may be experienced due to the sheet metal welding to the backing. In these cases, if copper backing is used, no difficulty is experienced as the copper conducts heat much more rapidly than steel or iron.

Regarding the welding of manganese steel, Mr. Kinkead said that in the cross-over work and special frogs and switches a steel which has practically the same composition as the original, about 12 per cent manganese, can be put down. In this case, however, it has been found to work best if the electrode is used as positive and the work as negative. In this case, 12 per cent manganese wire would of course be used.

In regard to the light of the arc injuring the eyes, the speaker stated that the rays act just like sunburn, in that the light will burn if you expose your naked eyes to it. It will scar the outside of the eyeball and will make the eye sore for about a day after careless exposure, but it is not likely to permanently injure the eye.

Flame Welding of Cast Iron

Applications of oxy-acetylene welding for specific purposes were given by Mr. Dyar. "In welding cast iron," he said, "the piece is first prepared by chipping out the crack in the form of a V so that the weld can be made the entire thickness of the metal, thus producing a weld of full strength. In handling cast iron where the shape is somewhat irregular, as is usually the case, the proper heat treatment is fully as important as the actual making of the weld. For ordinary work the casting should be heated very slowly, usually in a charcoal fire, until it has become a dull red and any expansion strains taken care of; the weld should then be made while it is still at this temperature and afterwards cooled down very slowly."

Relative to the difficulty often spoken of in welding cast iron in which the welded spot is too hard to be machined, Mr. Dyar said that this can be prevented largely by the proper heat treatment, but that there are, however, a number of other things that have a bearing on this. For instance, if a neutral flame or a flame that contains a little excess of acetylene be used, the probabilities are that a soft weld will result.

As to the cause of the hardness, Mr. Dyar said: "My theory of that is that if the welder is not quick with his work, or if he uses a torch that produces an excess of oxygen in the flame, he is liable to burn out of the cast iron the free carbon. As we all know, it is the free or graphitic carbon in the cast iron that makes it soft. If you burn that out, you approach to a greater or less degree the white iron, which has practically no free carbon in it. I have heard a number of other theories, but I believe the one I just gave is probably the most accurate. If you watch the weld and see that the torch does not give an excess of oxygen you will not have a great deal of trouble." Sometimes, he said, if a cast iron weld is allowed to cool too

*Now Lieut. Kinkead U. S. N.

rapidly it will be chilled and often extremely hard. Another factor is the filled rod. The silicon in the filler rod, he pointed out, is to absorb or do away with the phosphorus and sulphur and other elements of the iron that would be destructive, and the filler rod also contains quite a high percentage of carbon. "If you can get free carbon in the weld it will be soft, and if you do not it is pretty likely to be hard."

Flame Welding of Steel Plates

The speed of steel welding, Mr. Dyar said, varies almost directly as the thickness of the metal varies; for instance, on No. 14 gage a good welder will run along at the rate of 6 in. a minute, whereas on ¾-in. plate a man probably would not weld more than 1 or 2 ft. per hr. Relative to the tensile strength of the weld as compared to the original metal, he said: "We find in practice that where the weld is of the same thickness as the plate you can count on around 75 or 80 per cent for an average job." He pointed out that "It is practicable wherever possible to make the weld of greater cross section than the sheet, in which you can always count on over 100 per cent joint. The increase in cross-section would be about 25 per cent, and I believe if you pull a weld of that kind properly made it will not break in the weld."

Flame Welding of Die Castings

"Up until about a year ago if we got a die casting in the shop," Mr. Dyar said, "we would let it stay there until some one came and got it. We could not do much with it. But I find now that most all of the die casting alloys can be handled to a more or less satisfactory degree by the use of tin. We have done some very satisfactory jobs on automobile parts and lubricator parts and pump parts and magneto parts, die castings, by simply using block tin."

Oxy-acetylene Cutting

On the subject of the cutting of steel with the oxy-acetylene flame, Mr. Dyar said: "Steel up to a thickness of about 20 in. can be cut by a tiny flame about as rapidly as wood can be sawed. The torch used for this work is similar to the welding torch, except that in addition to the regular oxy-acetylene flame a jet of pure oxygen can be turned on which actually does the cutting. The piece to be cut is heated on the edge with the regular flame, after which the oxygen is turned on. A hand-torch is used for miscellaneous work such as cutting out patches in boilers, cutting irregular shapes in plate which were formerly punched out, cutting steel 'I' beams and in wrecking steel buildings. In a number of cases this work has been done at from one-fourth to one-sixth the cost of any other method. One important use is the cutting of risers on steel castings."

"Comparing the oxy-acetylene and oxy-hydrogen flame," the speaker said, "for cutting up to, I would say, 8 or 10 in. thick, the oxy-acetylene is best and cheaper. For cutting over 10 in. thick, and from there on up to the limit, the oxy-hydrogen flame is better. I believe one reason is that the oxy-hydric flame is not a short flame; it is more likely to be a long tongue that comes down into the cut and keeps the oxide flowing out. If you do not get the heat deep enough you are liable to get a frozen cut."

Electric Butt Welding

Electric butt welding, Mr. Clapper explained, is used extensively in the metal industries in the uniting of forged parts into one complete part which would be impracticable to make in one forging, the uniting of forgings to tubular and rod parts; welding wheel rims and bands, and so forth; high carbon and alloy steels, welding the longitudinal seams of formed steel tubing, uniting of dissimilar metals, as steel and brass. He pointed out that while butt welding work may be done to conform to certain over-all dimensions limits of the welded piece, practically no attempt is made to work to absolute dimensions. In the forming and welding of rims, bands and so forth, the ring after welding will only approximate the finished circumference dimension. In ring welding work it is therefore necessary to put the rings through a sizing operation, which may be accomplished by either shrinking of stretching. Except on the heavier sections this sizing is done with metal cold. The stretching operation is an excellent test of the weld. "In the making of electric welded tube, the forming and welding is done to base dimensions, the finished size being produced by drawing or swaging.

In practice it is often desirable to add to the length of a piece of steel shafting, or perhaps cut off a worn section and weld on a new piece. To insure a true running shaft, the speaker said, the practice is to weld on a piece of larger diameter than that of the section to which it is joined. This is then put into a lathe and turned to size. The butt welding of tube seams presents difficulties not encountered in the ordinary joining of parts. A specially designed machine is used through which the formed tube is passed, the welding being accomplished while the tube is in motion. Removing of the burr after welding, Mr. Clapper said, is necessary except in a few instances. The inside burr in welded tubing is, for some kinds of work, not objectionable and may be left in. This burring operation may be accomplished in several ways. It is removed from tubing by passing the tube under several cutting tools and finished by grinding. Rod work is put in a lathe and turned off. The burr may be removed from bar welds by either a burring tool or a gas flame.

In every field within its scope where electric resistance welding has become a competitor of other processes of welding, Mr. Clapper claimed, it has been found more economical. Being free from objectionable features of smoke, glare, soot and dirt, so common with other processes, a greater ouput per man can be obtained with less fatigue and less operating cost.

—*Iron Age.*

ARC WELDING SCHOOLS GIVE FREE TRAINING

A misunderstanding that has existed in the minds of several men interested in electric welding, due to the belief that there was some charge made by the Emergency Fleet Corporation for training electric welders, is cleared up in a statement issued by H. A. Hornor, head of the Electric Welding Branch of the Education and Training Section. No fees are required for this particular service, Mr. Hornor says, the Company merely paying the wages and expenses of its men during their period of training.

The Education and Training Section has established a special branch for handling electric welding problems and training, and this service is open free to shipbuilders or those aiding shipbuilders, or the government, doing important war work.

The training centers are schools to give intensified practice in the use of metal electrode for electric arc welding. Three schools are in existence, one in Cleveland, O., one in Schenectady, N. Y. and one in Brooklyn. A center also is to be established in Philadelphia. It will be ready for students in two or three weeks. The procedure of entering these schools is very simple. It is necessary only to inform the electric welding branch as to the number of men that are to be trained and when they are to be sent to either of the training schools. When this information is supplied, all arrangements will be made to take care of the men.

A further course of instructors' training will be given any man upon completion of his electric welding training work, so that companies desiring it can have the benefit of the man as a skilled instructor.

The Fleet Corporation will certificate any men who is sent for this specialized training, after he has performed sufficient production work to insure that he is proficient in electric welding.

WELDING TO BE USED IN WAR RECLAMATION

Three hundred men from the Ordnance Department, United State Army, will be trained as electric welders in the welding schools established by the Electric Welding Section of the In-

strial Relations Group, according to an announcement by A. Hornor, Head of the Section.

These men will be used in the work of reclamation of millions dollars worth of war materials gathered from the battlelds of France. Ten men of the Expeditionary Forces already e in training at the Cleveland School, according to Mr. Hor-r, and the remainder will be sent to the schools in relays. It is estimated that millions of dollars will be saved to the ar Department through this work.

Ship welders are being trained without charge in the schools of the Electric Welding Section. There are schools at Schenectady, N. Y., and New York City, in addition to the Cleveland School, and a fourth course is being started in Philadelphia.

ACETYLENE CONVENTION POSTPONED

The Secretary of the International Acetylene Association announces that the regular annual meeting of the Association has been postponed. The announcement follows:

"A careful canvas of the membership of the International Acetylene Association has disclosed the fact that the industry is so intensely engaged in direct and indirect production for war purposes that it would be unwise at this time to give up a week or a moment to anything, even though it be as important as the Annual Convention.

This is a time when everyone connected with the industry must do his bit if ever and, as was well expressed by one of the members, "should stay at home, stick to his job, taking the money we would spend for the Convention to buy Liberty Bonds." We should let nothing interfere with a maximum production, for our country needs all the work there is in us. There will be time enough to celebrate when victory is won. Then with a clear conscience every acetylenist can meet his brothers with a certainty that there is not a slacker to be found.

Therefore the meeting will be postponed. Let us hope that victory will make it possible for us to meet long before a year from now."

BOILER REPAIRS BY ELECTRIC WELDING*

Development of the Arc-Welding Process—Description of the Equipment—Examples of Application of Process to Boiler Repairs

By R. S. Kennedy

It is hardly necessary to state that welding is one of the oldest branches of the working of metals. In some respects it is a lost art, as there are good grounds to believe that the ancients were able to weld some of the bronze alloys.

In the following remarks the author proposes to confine himself to the welding of iron and steel, unless otherwise stated. A weld is the intimate union of two pieces of metal produced, when the pieces have been raised to welding heat, by pressure or hammering, and the welding state of the metal only exists within a limited range of temperature, being something like 100 degrees for iron and steel but varies with the metal. As a rule, good iron will stand a higher temperature than steel, although certain steels, such as blistered or good shear, will stand a high temperature. In the smith's fire steel can and should be forged with a lighter tool than iron, the blows being in rapid succession. In the ideal weld the two surfaces to be united are brought to the plastic heat together, neither at too high nor too low a temperature, when the point of juncture should be as strong relative to its section as any other portion. From the foregoing remarks, however, it will be appreciated that much depends upon the skill and experience of the operator, and it is recognized in ordinary engineering practice that an allowance has to be made for inevitable human frailties.

The first process of electric arc welding to be employed in a commercial sense was that of De Bernardos, which was used in Messrs Lloyd & Lloyd's Works, over twenty years ago, in the welding of flanges and branches to iron and steel pipes. In the De Bernardos process a carbon is employed, an arc being drawn between the carbon and the job, a portion of which is brought to welding heat, and the added metal is heated in the flame of the arc. In the early Bernardos process the work was made the negative pole and the carbon the positive; but latterly the poles were reversed, thus doing away with the dangers of carbonization of the metal caused by the natural flow of carbon particles from the positive to the negative. The Bernardos process is still largely employed in this country.

Metal Electrodes

Slavinoff substituted a metal electrode for the carbon electrode of the Bernardos process, although Bernardos as far back as 1885 had the idea of using a hollow carbon filled with the adding metal. In fact, there is very little that Bernardos does not seem to have anticipated, his difficulty being that, like many other great inventors, he was in advance of the means and appliances of his time.

The names of many investigators and workers in our own and other countries during the eighties and nineties of last century could be honorably mentioned, each doing his little bit to advance what is practically a new trade. Among them Charles Lewis Coffin, of Detroit, U. S. A.; Mark Wesley Dewey, of New York, U. S. A.; Pouméa, of Altoria, nr. Hamburg; W. P. Thompson, of Liverpool; Thos. Odlum, of Virginia, U. S. A.; Francis Todd, of Newcastle-on-Tyne; Joseph Fouillond, of Paris, etc.

Electric arc welding is primarily a form of autogenous welding—that is to say, that the metals to be united are heated to such a temperature that they will fuse together on contact without the application of external pressure. It is, however, found in practice that the application of even the moderate amount of pressure produced by a hand hammer increases the tensile strength and tenacity of the weld from 5 to 10 per cent.

Pressure Improves Strength of Weld

It is, however, essential that this work should be put into the material when it is at welding heat, or, at any rate, above the black heat. It may here be remarked that it is often said that the value of metal added in this fashion is analogous to the ball of iron obtained in the puddling furnace. This, however, is not the case, and the better results are probably due to the fact that the iron wire used is of the very best material, with preferably a small percentage of manganese. This iron wire has been very heavily worked in the process of manufacture, and subsequently annealed, and as used by the writer's firm shows a tensile strength of 28 tons with an elongation of 50 per cent. Somewhat similar results are obtained in another field with cast iron, which has several times been remelted. The whole question of the amount of work put into the material of a weld is very fascinating, and there is no doubt that the capacity of a weld for taking up rapidly-alternating strains for a long period, and for absorbing sudden shocks, very much depends upon this factor.

Returning to our blacksmith, we find that they all employ some kind of flux, usually sand or borax. This flux surrounds the heated iron or steel and protects it against the impurities of the fuel, removing at the same time the coating of the scales. Some impure wrought irons flux themselves, but with steel other mixtures are used. The flux, as its name indicates, also increases the fluidity of the heated metal.

In electric arc welding with a metallic electrode one great advantage is that, with the exception of the atmosphere, we have no impurities to guard against, except such as are introduced in the materials. The source of heat is pure,

**From a paper read before the Institute of Marine Engineers, London, March 12.*

and we have to see that the job is properly cleaned and the metallic electrode of suitable material.

Still, to provide against oxidization and also to increase the fluidity of the metal a flux is necessary to good work in arc welding, and the heated metal is protected from oxidization by an inert gas given off by the flux. The most convenient method of applying the flux is to coat evenly the metallic electrode, thus providing a constant and uniform supply.

Electric arc welding is a process of building up, and consists of adding metals to an existing structure. For this type of welding the electric arc has one great advantage in its high temperature. This is the highest known, and thus by the application of a small number of calories a part of the job, say about ½ inch diameter, is almost instantaneously raised to welding heat, and the drop of adding metal from the pencil, also at welding heat, is united to it, and the process of building up is continued till the required section is reached. The small quantity of heat required does not cause any undue expansion of the job in hand, and contraction troubles are reduced to a minimum. It is quite a common practice to weld over a riveted seam, although in this case it is necessary that rivets in the area dealt with should be completely welded over, and not left half covered. After welding a seam it is necessary to calk the landing edge for some 6 inches at each end of welded portion. Cracks in furnaces, end plates, combustion chambers, etc., are dealt with by cutting out the defective portion, leaving a V-shaped opening, which is filled in with the welding material. Work can be carried out directly overhead, or in any position that is accessible to the welding pencil, and where the operator can see what he is doing. As the work is one requiring constant attention on the part of the operator, it is advisable, in order to get the best job, to make it as accessible as possible, and that the operator should be reasonably comfortable.

In common with all hand welding, a good job depends on the conscientious work of the man. The writer's firm have always trained their own welders, and keep them in constant employment. A full report is made of each job, and the name of the welder recorded, and the whole object of the training is to inculcate a sense of responsibility.

The materials at present dealt with on a commercial scale are wrought iron and steel and cast steel, and occasionally cast iron. The range of temperature of the welding heat is the determining factor in the adaptability of a substance for welding. Much successful work has been done with cast iron, notably with castings of considerable age, which have not been subjected to corrosive action, and with the good mixtures of more modern times. It is probable that there is a welding temperature of cast iron, but the range of this temperature is very small, something of the nature of 10 degrees.

The voltage across the metallic arc is about 22 to 25, and the writer adds an equal steadying resistance, which makes the voltage at the terminals of the dynamo about 45. A substitutional resistance is employed which is put in circuit by an automatic switch, when the welder breaks his arc, thus keeping the load on the machine constant. The amperes actually employed are about 175, but in practice a 200 ampere machine is necessary, while the writer's firm use machines designed for 250 amperes. In the big passenger liners it is the practice to weld from the ship's dynamo, suitable welding and substitutional resistances being provided.

By a special winding of the dynamo, known as separate excitation, the machine can be steadied under varying loads, but even in this case the writer still prefers to retain the substitutional resistances in addition.

The design of the portable machinery for generating electricity presents many interesting problems. The plant is designed to meet the varying conditions, consists of wagons generating their own electricity, portable gasoline-driven generating sets, self-propelled or dumb barges with steam-driven or kerosene sets, steam turbine plants, and last, but not least, the motor generator sets.

This last plant is of great service in a port like London where the docks are well served with electric power mains at a constant voltage. The design of the dynamo is a matter for the electrical engineer, but the conditions of working are trying, and it is advisable to have ample commutator surface and good ventilation, as in urgent marine repairs it is possible that a machine may be asked to run continuously for two or three weeks.

The preparation of a job for electric welding is a matter of considerable importance, as the presence of impurities is likely to be detrimental to the weld. In dealing with the external of fire surfaces of a boiler it is usually sufficient to use an ordinary chipping hammer, and then thoroughly wire-brush the metal to be dealt with; but some superintending engineers prefer to have a light chipping taken over the surface, which is, of course, the ideal preparation. In marine work, however, the time available is often so short that as a general rule the former method is adopted. When, however, it comes to dealing with the water surfaces of a boiler greater care is necessary, especially if zinc plates have been freely used. The welder, if a properly-trained man, would at once recognize this difficulty and apply the only remedy, which is to chip down till pure metal is reached.

Arc welding being a building-up process, cracks are dealt with by veeing out at the line of fracture, the vee being made wide enough to ensure that the welder can reach with his pencil to the bottom on either side with a certainty of striking his arc at any required position. As the welder is a highly-skilled man, it is usual for the boiler makers to prepare the work to instructions, and the welder himself puts in the finishing touches. The welding in of new backs to combustion chambers or tube plates, or work of that kind, is dealt with in precisely similar manner, although here certain allowances have to be made for the work drawing together as the welder proceeds. It should be mentioned that in dealing with cracks it is absolutely essential that the whole of the fractured portion be cut away, and a very good guide is to cut away till a solid chipping is obtained, and then go a bit deeper to be on the safe side. If welding is carried out over a partially cut away fracture it is certain that sooner or later it will work to the surface. One of the most unsatisfactory matters we have to deal with is the welding of a crack in the original weld of a furnace, as it is most difficult to say where the defective weld ends, and a further defective portion some short distance along may work back into the part dealt with.

As in all engineering matters it is better to know the worst and to deal with it. The writer recalls an incident in our early days—about 1910—when we were called in to weld a crack, apparently about one inch long, in the back of a combustion chamber of a Swedish vessel. Our man started to cut out the crack when, with a loud report, the chamber back split right across, showing a fracture a full sixteenth open. This caused great alarm at first, and we were charged with using undue vigor, but on veeing out the fracture for welding it was found that the back was grooved right across on the water side, so we were exonerated. It is a merciful dispensation of Providence that such defects develop mainly when the boiler is cold or under banked fires, and it is generally recognized that a boiler is never safer than when warmed up and steaming steadily. Owing to its high temperature the electric arc is more suitable for dealing with the heavier sections than the oxy-acetylene or oxy-coal gas

(Continued on Page 48)

AUTOMOBILE WELDING

With the OXY-ACETYLENE FLAME By M. Keith Dunham

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CONTENTS

CHAPTER I—APPARATUS KNOWLEDGE—Oxygen Supply—Care of Oxygen Cylinder—Acetylene Generator—Care of Generator—Regulators—Care of Regulator—Creeping Regulators—Gauges—Care of Gauges—Welding Torch—Care of Torch—Hose and Goggles—Effects of Heat—Hose and Goggles

CHAPTER II—SHOP EQUIPMENT AND INITIAL PROCEDURE—Welding Tables—Location of Welding Outfit—Adjustment of Flame—Principle of Welding—General Welding Knowledge—Welding Rods and Fluxes—Choice of Tip—Expansion and Contraction.

CHAPTER III—CAST IRON—Simple Welding—How to Hold the Flame—Hard Cast Iron—Pin Holes and Blow Holes—Lug on Cylinder—Water Outlet—Cylinder Welding—Compression Head—Finishing and Testing—Scored Cylinders—Cylinder Parts—Fly Wheels—Pistons—Crank Cases—Babbitted Bearings—Valve Guides—Preserving Threads—Conclusion of Cast Iron.

CHAPTER IV—ALUMINUM—Use of Welding Knowledge—Puddle System—Welding System—Comparison of the Weld—Inlet Manifold—Arm of Crank Case—Weld—Preparation of Crank Case—Welding the Arm Without Taking out the Motor—Break in the Body of Case—Welding Cold—Wrong Method of Setting Up—Lug or Boss Welding—Preheating the Case—Gas Preheating Flame—One Side or Both—Collapse of Weld—Broken Heatings—Direction of Weld—Shrinkage Cracks—Missing Parts—Finishing—Die Moulded Castings—Body—Other Parts.

CHAPTER V—STEEL—What the Welding Knowledge—The Welding Flame Does to Steel—The Welding—Position of Rod—Simple Welding—Position of Flame—Reinforcing the Weld—Frame Welding—Lengthening the Chassis—Tube Housings—Worn Parts—Gear Welding—Case Hardening—Tank Metal—Welding—Gasoline Tank Welding—Construction of Parts—Shaft Welding—Adjacent to Rivets.

CHAPTER VI—MALLEABLE IRON, COPPER, BRASS, BRONZE—How to Detect Malleable Iron—Brazing Malleable Iron—Rear Housing—Reinforcing the Braze—Brazing Tube to Housing—Building Up Worn Parts—Copper—Brass and Bronze—Silver Soldering.

CHAPTER VII—CARBON BURNING AND OTHER USES OF OXY-GEN AND ACETYLENE—Principle of Carbon Burning—Method of Operation—Lead Burning—Soldering—Case Hardening—Heating Uses.

CHAPTER VIII—HOW TO FIGURE COST OF WELDING—Oxygen Consumption—Dissolved Acetylene Consumption—Torch Consumption—Cost Card—Conclusion.

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608 S. Dearborn St. **CHICAGO**

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Weld Liberty Bell

THE suggestion we made in the September issue, that the old Liberty Bell should be welded and made ready to ring out the news of the submission of the Hun, has drawn many replies. One leading Chicago newspaper indorses the plan.

In connection with the welding of church bells we received a communication in 1916 from Mr. S. W. Miller, which we reprint here for the benefit of our new readers.

"I notice in your November issue an article in regard to welding a church bell, and as the inquiry asks for suggestions, I desire to submit the following:

"Bell metal is usually composed of about 80 per cent copper and the rest tin, with possibly small amounts of other metals to produce a certain quality of tone.

"Bells of the size referred to, 1,600 pounds in weight, are slowly cooled. These proportions of copper and tin produce a hard, brittle metal, because of the large amount of what is called the delta constituent, which, under the microscope, shows white and brilliant, and which is very hard and brittle. The large percentage of this constituent, which is an alloy of copper and tin, contains approximately 70 per cent copper, and of which therefore bell metal largely consists, makes the bell metal hard and brittle. Any alloy of copper and tin containing this constituent is more or less difficult to weld, not because the metal cannot be united, but because of the fact that the delta constituent is of a much lower melting point than the rest of the metal, so that it solidifies last and melts first.

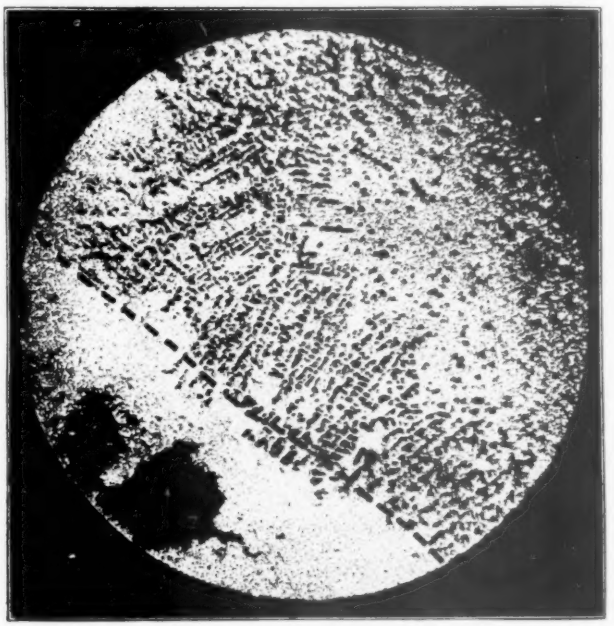
"During the heating of the bell metal by the welding torch, it will be noticed that at a certain point below the melting point of the metal, small beads or globules exude from the surface, and dance around as do drops of water on a red hot stove. As the welding material is added, these globules are absorbed by it. There must therefore be a line in the original material, from which this low melting constituent has been driven out by the heat, and inasmuch as there is nothing to replace it, cavities must be left to replace it near the line of the weld. This, of course, makes the material weaker at this point than elsewhere, aside from any effect due to the change of grain size caused by the heat.

"This is readily proven by miscroscopic examination, and I enclose you a microphotograph showing this damage to the original material.

"This microphotograph is of an alloy which analyzes 89.11 per cent copper and 10.76 per cent tin, and the welding material used was the same. The photograph shows the added material on the right, and the original on the left, the line of the weld being at the edge of the small holes. These small holes show where the delta constituent has been boiled out by the heat. It will be noticed that damage decreases as the distance from the weld increases, which would be perfectly natural.

"Such an alloy as is mentioned is not suitable, of course, for welding, but was used during a series of tests for certain purposes.

"However, no matter what the alloy used, this damage to the original material occurs to a greater or less extent. It can be minimized but not avoided entirely, because the effect is due to the heat. Therefore, I believe it is impossible to weld any copper-tin alloy and get the same strength as in the original material. As a matter of fact, with the best welding



Section of Welded Bell Metal.

material, the breakage of the test pieces always occurred through the line of these holes. I believe that this is the reason for the breakage of the bell in the place referred to, and while it may be possible to make a weld with such material that will last for a while, I am afraid that a permanent repair is out of the question.

"I might say in this connection, that while Tobin bronze is very largely used for welding, I have never yet seen a weld made with it that was not more or less porous, although its strength is so much greater than the average brass or bronze casting, that this does not usually cause trouble. Any usual brass and bronze castings that are welded are designed from a foundry standpoint, i. e., it is made thick enough to cast readily, and this thickness is usually far more than is requisite for strength, so even if the weld is somewhat imperfect, it is strong enough, and as very few welds are examnied for porosity, the condition that exists passes unnoticed.

"I write this note because of the tendency on the part of all of us who are interested in oxy-acetylene welding to apply

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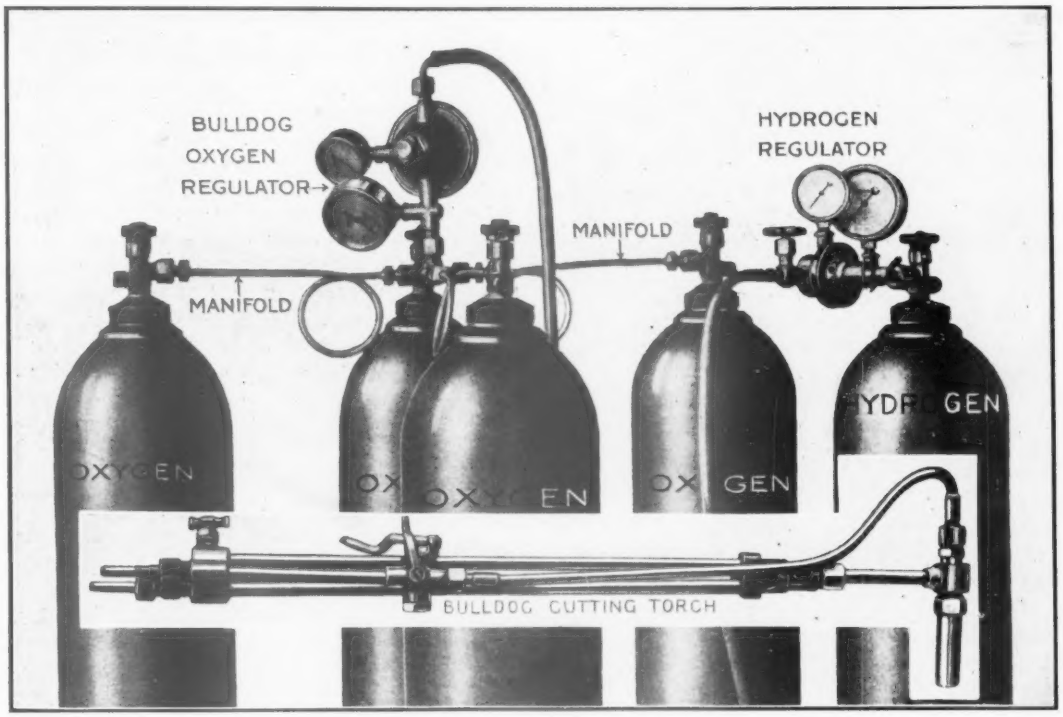

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the process where it should not be used, and because I realize that the conditions above mentioned are not generally known. I certainly do not want to discourage the use of oxy-acetylene welding, but I do feel that the sooner it is realized that there are conditions under which it is not applicable, the sooner will defective welding cease.

"I would also criticise your instructions in regard to chilling the bell in water; such treatment on a bell of this size would probably result in serious internal strains, and inasmuch as such bells are always cast in sand, and allowed to cool slowly, the ordinary cooling in a charcoal fire would be, in my judgment, the only proper method.

"I would also say that I believe heating the bell with a gas torch would produce strains in it, because it is impossible to keep it anywhere near a uniform temperature. I have found that the only way to heat large bronze castings, and we have welded some that weigh as much as 4,000 pounds, is to use a charcoal fire and allow them to cool slowly in it."

Bulletin No. 11

ONE of our lawmakers at Washington recently made the statement that "Every little Bureau has a bulletin of its own." This thought is amply illustrated in the recent publication by the Federal Board for Vocational Education of Bulletin No. 11, the title of which is "Emergency War Training for Oxy-Acetylene Welders."

In introducing this Bulletin the Director of the Board has this to say:

"As has already been shown in previous bulletins of the Federal Board for Vocational Education, there is a critical and constantly growing need for many thousands of mechanics and technicians for Army occupations carried on in and behind the lines of the United States Army. Many of these workers, already experienced in similar occupations of civil life, will be secured through the draft, and possibly through voluntary enlistment. It is recognized by those in a position to know that the quota thus gained will not be sufficient, and that it will be necessary to train many thousands of men in various ways for various occupations. The War Department has taken definite steps to provide for this training systematically through Army schools, in some instances at cantonments, but largely at the industrial, trade, and engineering schools of the country.

"For some months the Federal Board has been making intensive investigations and studies of the demands of these Army occupations. A series of bulletins for the guidance of those giving this training has resulted from these studies. The courses and methods suggested in these bulletins have been carefully checked by experienced Army officers and represent the consensus of opinion as to what training should be given and how it should be given.

"Persons desiring to secure copies of any or all of these bulletins can readily do so by applying to the Federal Board for Vocational Education, Washington, D. C.

"This bulletin is the seventh in the series, being preceded by Bulletin No. 2, Training Conscripted Men for Service as Radio and Buzzer Operators; Bulletin No. 4, Mechanical and Technical Training for Conscripted Men in the Air Division of the United States Signal Corps; Bulletin No. 7, Emergency War Training for Motor-Truck Drivers and Chauffeurs; Bulletin No. 8, Emergency War Training for Machine-Shop Occupations, Blacksmithing, Sheet-Metal Working, and Pipe Fitting; Bulletin No. 9, Emergency War Training for Electricians, Telephone Repairmen, Linemen, and Cable Splicers; and Bulletin No. 10, Emergency War Training for Gas-Engine, Motor-Car and Motorcycle Repairmen. The above bulletins were issued to meet the need for trained men of the United States Army, and they might be called 'Army service bulletins,' as contrasted with 'occupational bulletins.'

"The first two bulletins dealt entirely with the need for trained men in specific occupations in the Signal Corps. Now that the needs of the other branches of the service have been charted, and the work of training is being put on a definite and systematic basis, it will be possible to establish training schemes to fit men for occupations in a number of different branches of the service, leaving to the War Department the task of distributing these men after they have been trained.

"In this way the specific needs and requests of the different branches of the Army for the same kind of trained men will be equitably met. It is expected that the courses and methods suggested in these bulletins, will form the basis of practically all the training given under Army auspices for practically all of the occupations dealt with in the bulletins.

"The purposes of the courses outlined in this and other bulletins can not be emphasized too strongly. They are war emergency courses in the fullest meaning of the term. They are not trade courses in the sense that they attempt in any measure to prepare men for recognized trades and occupations as carried on in civil life. They are short, brief, direct courses of instruction designed to fit men, in a great emergency, to meet the specific demands of processes and operations carried on by an army under war conditions, which in most cases approximate the demands and requirements of similar work in civilian occupations.

"Men taking this kind of training should not be led to believe that they are learning a trade. They are serving their country by learning to do a special job well, and to some extent this training may be beneficial to them in after life."

The basis for Bulletin No. 11 has evidently been the work of a well known Welding Institute, but in attempting to publish the work of this Institute in Bulletin form a lamentable failure has been made. The Institute in question possesses the services of a staff of skillful welding engineers, to whom a skeleton outline of a course of instruction in oxy-acetylene welding means something. To the average college professor, or welder, for that matter, Bulletin No. 11 means nothing.

Is Welding a Trade?

THE Federal Board for Vocational Education says, in Bulletin No. 11:

"A WELDER.—A welder (oxy-acetylene) is a person who has the requisite manipulative skill and knowledge to successfully operate oxy-acetylene welding and cutting apparatus and, at the same time, has skill in the operation of hand tools used in the preparation and finishing of work in connection with welding and also has a reasonable amount of ingenuity. He must also have a knowledge of accuracies commensurate with the type of work required to be welded (accuracies comparable with those required in the original production of the article being welded).

"Owing to the ranges of accuracy in various classes of metal work where welding can be used, e. g. boiler welding or crankcase welding, it is desirable to define the word "welder" by hyphenating with it a word describing the class of work, such as boiler-welder, foundry-welder, and aircraft-welder."

A TORCH OPERATOR.—A torch operator is a person who has the requisite manipulative skill and knowledge to successfully operate welding and cutting torches, but due to deficiency in knowledge of mechanical practice can not fill the whole requirement of the definition of a welder.

A torch operator may have a knowledge of the operation of the welding torch only and this over a limited range of work, but as far as the actual welding is concerned may be able to carry out the work as well or better than a welder.

NOTE.—The successful completion of a war training course in welding will produce either a torch operator or a "welder," dependent upon the previous experience of the student. If this experience is inadequate to produce a welder, additional instruction in general mechanical work can be given to make up the deficiencies.

A CUTTER OR BURNER.—A cutter is a person who has the requisite manipulative skill and knowledge to successfully operate a cutting torch.

WELDING NOT A TRADE.—Welding is not to be considered as a trade in itself. Ability as a welder is valuable to a mechanic, but one whose mechanical experience is limited to welding only should be classed rather as a torch operator.

SELECTION OF STUDENTS.—In the selection of men to be trained for a specific kind of welding it is desirable to select men who have had experience in closely allied work, e. g., boiler makers as helpers selected for boiler welders. In general, men who have had experience as machinists, blacksmiths, plumbers, welders, pattern makers, tinners and other metal workers will be found to make more rapid progress than those not having had some mechanical training.

It is the opinion of *The Welding Engineer* that the art of welding is a *trade*, in every sense of the word. There is no such thing as a "torch operator," as expressed by the Board. There are "Master Welders," and there are other members of the trade who are not Master Welders, but who, under the English system, would be graded as Class A, B or C welders.

This would seem to be a case where *organized* labor, recognized by the Board as *organized* labor, claims all the credit for and disclaims all the responsibilities of a highly specialized industry.

It would seem that the findings of the Board, as expressed in Bulletin No. 11, were based on a very limited knowledge of conditions.

"Kick In"

FOR the benefit of those who may have overlooked the message in our September issue we are reprinting an editorial from that issue.

The Welder's Debt to France

In addition to standing guard over the Hun the French have done something for American welders. From France has come a good part of what we know about welding, and it would be fitting indeed, if American welders could do something for French welders.

A friend of *The Welding Engineer*, Mr. C. J. Nyquist, writes us as follows:

"Mrs. J. Linden Smith, representing the Franco-American Committee for the care of children from the Front, writes in the New York Times, as follows:

"'The number of children needing assistance, a number constantly on the increase, has now reached the stupendous total of 600,000. Of these the French government is caring for about 400,000. The rest of the work must be done by Americans.

"'France is dotted with a multitude of homes in which the mother, with the head of the family at the Front, perhaps dead, is struggling to care for her children and to keep the wolf from the door. These mothers toil early and late. Some of them have little patches of ground which they make shift to cultivate. Poverty lurks side by side with them constantly. They try to keep the family together —to keep the children with them. Only under dire necessity will thy consent to part with them.'

"The members of the oxy-acetylene industry in this country, whether welders, apparatus mechanics, manufacturers or supply dealers, certainly are under much obligation to France, where the process originated and where the most important developments of this process have been made.

"I believe it would be a handsome thing for us to do to get together and help to make the coming Christmas a happier one for some of those unfortunate children, many of whom, no doubt, are the children of French welders. Permit me to suggest, Mr. Editor, that you publish an appeal to our welders, and others benefited by our industry, for Christmas subscriptions. If necessary, let us organize a Relief Committee, and put the matter up to every individual that can be reached to give every assistance, whether large or small, and I am sure that we will be able to bring a great deal of Christmas joy into many of those struggling homes.

"Mr. P. Rosemberg, one of the Directors of de l'Office Central de y'Acetylene, Paris, is well familiar with the situation and would, I am sure, gladly take care of the distribution of our gifts."

"C. J. NYQUIST."

It would be a fine thing to send a Christmas gift to the children of French welders. The money could be collected and forwarded to Mr. P. Rosemberg, to be used to the best advantage, and we are sure many a little heart will bless the men of this country who remembered them at such a time.

There is no time to be wasted. Contributions, no matter how small, should be made at once. The Editor of *The Welding Engineer* will accept them and will transmit the receipts to our friend Rosemberg. No matter how small your gift—remember its for small folks—the little fellows whose fathers made it possible for our boys to be there in time. Send a dime or a dollar—it's receipt will be acknowledged in these columns. Send remittances to L. B. Mackenzie, care *The Welding Engineer*, 608 S. Dearborn Street, Chicago, Illinois.

The contributions to date have not been as generous as we expected, but there is still time to register your opinion. The contributions so far have been from:

Bastian-Blessing Co.	$50.00
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Ray R. Ochenweider	1.00
Total to Date	$212.00

A license authorizing this solicitation has been issued by the State Council of Denfense of Illinois, License No. 698.

War Has Helped Welding

THE war has done a lot to educate men as to the possibilities in welding systems. We are about to try out a new cargo ship, the plates of which were spot welded, and then weld with the arc. Of course the process will be a success. Ship builders may regard it as an experiment, but welders do not.

A friend in France tells us welders are doing more than was expected of them. They are making the most difficult repairs, in fact they are doing work which would not be attempted here. When they come back their experiences will be interesting.

At home our manufacturers have been forced to weld. They have found it very successful and when they stop welding munitions they will weld something else.

CAST IRON BOILER SECTIONS

Editor:

I have a job coming up of three cast iron boilers. I can weld them but the preheating bothers me. Boilers are of different sizes. The largest one is 2½ ft. high and about 18 in. in diameter. How could I preheat them to prevent cracking?

I. J. L.

Answer:

Preheat them to a dull red. Build a fire brick furnace for every boiler, allowing a four-inch fuel displacement on all sides of the boiler. See that the bottom of the casting is supported. Use charcoal and allow the boilers to heat slowly. If one side gets hot quicker than the other, close up the draft holes on that side. After welding close up every draft hole or crevice with fire clay and allow boiler to cool slowly. Editor.

IS WELDING A TRADE?

By B. K. Smith

To review the recent ruling by Mr. McAdoo, Director General of Railroads, and compare it with the history of welding in this country, one cannot help discovering the old chronic defect of some labor men. You men that have families have probably noticed how your first born becomes jealous of the second born child. Any antagonistic action of the older child is looked upon by its guardians in a humorous way, because it is an infant. Yet we see in this ruling, which was recommended and insisted upon by a committee of organized labor unions, a similar antagonistic act against an infant trade, a trade which is struggling along unsupported and criticized by labor and capital alike, until it has won for itself recognition among the important mechanical trades. The history of welding is as truly as romantic as any in industry. First, the crude methods attempted by a few men, their unsuccessful methods, lack of encouragement, lack of instruction, and abandonment of equipment, yet there remained a few men who with great tenacity have stuck to their posts and slowly progressed in their attempts to develop the welding of steel, then cast iron, followed by copper, brass and aluminum. During these courageous attempts some accidents happened, with loss of life or limb,

Exhibit of the Torchweld Equipment Co., at American Foundrymen's Association Convention in Milwaukee, Oct. 7-11th.

with the result that some states prohibited the use of oxy-acetylene welding. In addition to these obstacles, other craftsmen, like machinists, boilermakers and foundrymen, joined in the criticism of the welding trade as unsafe and unpractical.

Thus progressed the unfair fight of the oxy-acetylene welder for fifteen years, and today, when he is universally recognized, instead of being welcomed by his brother craftsmen and given a place under his own name, that he fought for fifteen years to earn, he is absorbed and divided into equal portions among the older and stronger craftsmen, for the good of the Cause, or in plainer words, "As a protection for American labor."

Men! Let's look this subject squarely in the eye. Is the welding trade really so dangerous or apt to deprive you of your jobs or prevent you from earning a living? And do you men really believe that you can control and regulate at your wish the progress of this trade, by appropriating the control of its operations and excluding the real veterans from operating or advancing the trade in general? How would the Machinists, for instance, consider the question of dissolving their trade and let the blacksmiths do all the machining on their forgings, or finish their own tools; or the boilermaker do all machining that belongs to a boiler; the foundryman do all the machining on their unfinished castings, etc? It would be considered as an attack on the machinists' tra[de]. Then, why take the welding trade and disintegrate it a[nd] divide it among yourselves? The blacksmith today is do[ing] welding at his forge for the boilermaker, machinists, p[ipe] fitter, tinsmith, and foundrymen. Why not swallow hi[m], too? Is it because his operations at the forge are limite[d]? Why could you not have a welding trade in your organi[za]tion to do all welding for the machinists, blacksmith, boil[er]maker, or pipe fitter, the same as the blacksmith has do[ne] for years? Is there really no more room at home for a younger brother that wishes to join his own people under his own name?

The writer really doubts that this is the general view taken by American labor. If a referendum vote should have been taken by all men who are competent welders, then such a ruling would never have been made in this country. Not long ago the writer knew an ardent organizer of labor who advocated that all welding should be divided and performed by all the old craftsmen, with the exception of tailors, shoemakers, waiters, etc. However, a time came when this individual thought that he could be more independent and make more money by starting in business for himself. But instead of starting business at his own trade of boilermaking he started an oxy-acetylene welding shop. He also had a great sign at his door stating that he could do all kinds of welding, such as broken crank cases, crank shafts, castings, frames, tubes and boiler welding. If this gentleman could have welded wood or glass, he would certainly have advertised to weld cabinets, windows, etc. Yet, according to his own made rule he was allowed to do only boiler welding. This case reminded me of an old popular saying that I heard in Roumania, "That what the priest does, the people shall not do." Now let's analyze the postion of the welding trade and see whether there is really any danger of a decrease in the operations of machinists, boilermakers and blacksmiths, with the increase of welding operations. Not at all.

Welding is an advanced and a noble trade for our advanced civilization. One invention helps another, and what could we do in this motor age, when the automobile, tractor and aeroplane have come into their own, without a welding blowpipe? It is a necessity of the present age. It is one of the foremost trades, based upon conservation, efficiency and economy. It is an established trade, recognized even in the smallest hamlet of the world. It is recognized by our Government to such an extent, that they build and establish schools of welding for men in uniform to learn *all* welding, regardless of any division or limitations. As a matter of fact, this young trade helps the further developments of the older trades, and, above all, it helps a great deal in winning the war for democracy and liberty.

No one ever heard that any railroad shop or any other large mechanical institution has ever decreased the number of machinists, boilermakers, blacksmiths or any other craftsmen because they have installed a welding plant. Therefore, why should organized labor invade another fellow's trade, and why should the other fellow be stopped from doing welding? The writer and thousands of others, some civil, some in uniform, are welding every day castings, boilers, pipes, and forgings. According to the rule of organized labor a man cannot perform all these operations unless he belongs to the machinists', boilermakers', pipe fitters' and blacksmiths' unions, which is impossible for one man to join.

However, the rules and regulations, the welding trade is no more an infant brother—it has become a powerful adult and it demands its right. It has knocked at the door of its older brother's home, but it has been abused and refused a proper admission. The welders will gladly organize as a welding trade, because that is the only way they can expect to grow and become proficient. The question is now, should

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they join with the older brothers, under their own name, or should they make a home for themselves?

Fortunately the writer believes that there will be no split, as the majority of our organized labor unions are composed of a good element that believes in the American ideals of justice and fairness, and it is the writer's hope that they will take a hand and give the welding trade a seat it well deserves.

British and French labor, tenacious as they are of their rights, have freely and cheerfully recognized welding as an established trade of its own, and there is no reason why this country's labor should not act for the future in the same manner and retain the old traditions of fairness and justice to all.

IS WELDING A TRADE.

Editor:

I have read Mr. Nels Johnson's article in the September *Engineer* and heartily agree that Oxy-Acetylene welding should be classified as a separate trade or profession.

The reason why we haven't been recognized is because anybody who could get a neutral flame and melt cast iron together called himself an expert and unfortunately others believed him such and if his work wouldn't hold up and people said "Well, John Smith welded it and it wouldn't hold and John's an expert, therefore, the fault was not John's but the process!"

There has been entirely too much cheap apparatus sold to the unsuspecting business world. Cheap apparatus is not only a menace to the user, but reacts harmfully to the welding profession.

I think I may be permitted to say "profession" because Oxy-Acetylene welding is an exact science and follows certain immutable laws which the welder must know and know how to apply to the individual case. Welders cannot be made at the rate of so many an hour like paving bricks. There are many men who are welding *at* things who should be cutting cord wood.

A man must be a born welder, and have a natural liking for working with heat.

A real welder knows more about a greater number of professions than any other kind of craftsman.

A welder's work varies from refining platinum to engine beds, etc., each individual case requiring different treatment.

A man who can pound down rivets and roll up flues is called a boilermaker and his work a trade. And a man who packs glassware in barrels or who makes barrels, or who lays brick has his work called a trade and is recognized as such but the art that is doing more than any other single tool or process to win the war and conserve the nation's resources must be called a "new tool" for Blacksmiths and Boilermakers to "burn" iron and steel together.

How I hate that word "burn." No other word was ever so inaptly applied.

The only way for the welding fraternity to be recognized is to organize and demand recognition.

F. E. Totten.

Editor:

In the August issue a letter from Arthur K. Lardry was published, concerning our trade and I wish to state that his sentiment meets my views right to a T. I do not see how a welder who does all kinds of repair work on all metals can be classed under any other trade than that of a welder. The art does not belong to any other trade, any more than the Blacksmith belongs to the Machinist or the Coppersmith belongs to the Sheet Metal worker. And any man, regardless of who he is, that has not had experience in the welding trade and passed through the (*mill*) work, is absolutely not qualified to class welders with any other trade. I am sure our brother welders realize that we must hold our own and not be trampled under when the trade is getting more important every day.

Reader.

WATER COOLED TORCH.

Editor:

We recently had several large jobs that took considerable welding. We were confronted by the same trouble of tip getting too hot. After trying different ways we finally found a simple yet effective way of doing long jobs at little expense. We had a large cylinder about three inches thick where we put a piece five by eighteen inches in and, preheating it from the inside, we had difficulty in getting to the bottom of it to weld without the tip getting too hot. Not having a water cooled torch, we rigged one up ourselves. We started the weld at one o'clock in the afternoon and two of us used the same torch, taking turn about, and welded continually fourteen hours on that steel job without taking the torch away longer than necessary to change tanks. Recently we had another long job to do while in the fire. It was a water jacket for a large bearing, weighing nearly two tons, having seven cracks, five welds inside and two outside. We used a long torch and welded continually on that job for ten hours, with the torch extending over the fire to the inside of the bearing. The torch never even got hot. You can get in the sharpest corners and never have any trouble or need take your torch out until the weld is completed. I think it has the manufactured water cooled torches beat because you can use it on any make. It fits any size tip. All a welder needs is a little hose and running water. This is the simplest and cheapest water cooled system a welder can install and I will guarantee it to do any job a man would want to undertake, and a whole lot more than he thinks it will accomplish. All that is necessary is a little copper tubing. But there are a few points that must be watched while using it, as it is too expensive to have something happen to the coil. One length coil with proper care will last for a very long time. I will gladly write to any brother who sends me his address stating fully how he can equip himself with a water cooled system and how to run it at very little expense. I have nothing at all to sell. All I know concerning the operation of such a system I will gladly explain to anyone wishing.

A Reader, care *The Welding Engineer*.

Editor's Note—Will the writer of the above letter please communicate with the Editor.

THE COST OF OXY-ACETYLENE WELDING

In discussing the paper on electric arc and oxy-acetylene welding read by A. F. Zoebrest before the Niagara Frontier Car Men's Association, Neil Marple of the Michigan Central quoted the following figures as the cost per cubic inch of welding by the oxy-acetylene process.

Size of weld in cu. in.	Amount of gas consumed	Amount of oxygen consumed	Amount of welding metals used	Material	Labor	Total
1.3125	15 lb.	200 lb.	1½ lb.	$0.88	$0.49	$1.37
3.75	50 lb.	350 lb.	2 lb.	2.99	.84	3.13
2.812	30 lb.	260 lb.	2¼ lb.	1.49	.70	2.19
2.32	32 lb.	265 lb.	2¾ lb.	1.61	.91	2.52
1.265	20 lb.	200 lb.	1½ lb.	1.03	.42	1.45

Acetylene 3 cents per lb., average 250 lb. per tank.
Oxygen 14 cents per cwt., average 1,800 lb. per tank.
Welding metal 10 cents per lb. Labor 42 cents per hour.

The average cost per cubic inch as shown by the above quotations is, approximately, $1.00 per cubic inch.

NEW "REGO" BOOKLET

A most interesting booklet has been issued by The Bastian-Blessing Co., Austin Ave. and La Salle St., Chicago, which explains in detail the new principle of this new line of welding and cutting torches. Mr. M. Keith Dunham, the inventor of this torch, and engineer for the manufacturers, has explained in this little booklet, in his usual clear and forceful style many points of great interest to the trade.

A large number of welders are being trained on the Pacific Coast, for various branches of the Army.

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ECONOMIC ADVANTAGES OF OXY-ACETYLENE WELDING

By A. R. Hodges*

It is not my purpose to deal with the origin and development of oxy-acetylene welding, neither is it necessary to discuss its wide application, which is unlimited, nor do I intend to tell you in detail, or as a whole, how to make various classes of repairs by this method. But I wish to speak of its economic advantages as a general proposition.

In the first place, it is a decided advantage in the subsequent upkeep and the maintenance of the locomotive in an efficient, serviceable condition. Under the old method of boiler work and engine repairs, leaky seams and rivets and defective side sheet patches, as well as many broken parts of engine and tender, rendered the locomotive incapable of efficient performances, and gave it decided disadvantage. But the oxy-acetylene welding process employed in boiler repairs completely eliminates all seams and rivets exposed to the direct attack of fire, and when patches are applied restores the plates to the original smooth surface; the life of the fire box is increased 100 per cent, and an original fire box applied by this method will last longer and render better service than when applied by the old method. This being true, it logically follows, therefore, that the outside casting sheet and back end of boiler is conserved accordingly. Therefore, leaky fire boxes from these sources, having caused so much trouble in the past and impaired the efficient performance of the locomotive, with a high cost of maintenance, are entirely overcome. Moreover, engine parts having broken, and become otherwise defective, making it necessary to remove the engine from service to effect repairs, which are performed effectively, and I might say, permanently, during regular layover in terminals.

I have comparative data which abundantly bears me out in this assertion, and the decrease in engine failures due to steam leaks establishes this fact beyond a doubt. Not only this, but repairs performed by this process to engine and tender make it possible to secure almost any mileage expected from the locomotive and the betterment of equipment will reach a higher percentage than can be obtained otherwise.

Then again, it is proving an advantage in making repairs to locomotives with great rapidity, thus reducing to a minimum the time an engine is held out of service for repairs. Under the old method, at its best, repairing boilers was a very slow process, requiring a great deal of time and of men, so that "we are waiting on the boiler makers" was a universal cry and the output of the shop was in a large measure dependent upon the boiler department. With the oxy-acetylene welding and cutting process, the rapidity with which boiler repairs are accomplished, removes this obstruction to shop output from the boiler department and makes an equal distribution of responsibility upon all departments, in addition to a minimum, reducing the time the engine is held for repairs. Then again, the heavy tonnage hauled, and the fast speed attained, is proving very trying on the engine parts, especially the frames. During the last 15 months we have had no less than 45 broken engine frames. This applies to one division, which maintains 138 locomotives. Under the old method of repairing this would have caused an enormous delay, even with splendid shop facilities of which we have been denied, besides compelling so many engines to be out of service. This, alone, would have forced a burden on us entirely too great. We would have been compelled to send these engines to the general shops for repairs, and they in turn would have been obliged to furnish us with other power. With the oxy-acetylene welding process all these engines have been handled in the Memphis terminals; and if a broken frame constituted the major trouble, only three days were necessary to make repairs and return the engine to service.

Another reason why oxy-acetylene welding is an advantage is it eliminates the necessity of maintaining a large margin of power to handle the traffic, reducing it, therefore, to a minimum. Under the old order, a large margin of power was essential, due to the fact that engines were held in shops an excessive length of time while undergoing repairs. It followed, therefore, that other power had to be substituted, and this was not always possible. If the system embraced many divisions the demand often proved greater than the supply. If the general shop was of sufficient capacity to handle the engines sent in from the various divisions with practically no delay, even then a goodly margin would be necessary; but if not, a congestion of power would be inevitable, which is almost invariably the case. This being true, each division master mechanic held his engine in service just as long as possible, before shopping, and when shopped, they would be outlawed from end to end. You can see at a glance that this is improper maintenance, and to overcome this improper handling a large margin of power is absolutely necessary. But with the oxy-acetylene welding process it is made possible to do extensive repairs to both boiler and machinery in a very short time, and should be properly termed running repairs, with no shopping charged to the engine. When locomotives are thus maintained, and it can be done, the large margin of power necessary can be reduced to a minimum. Every engine tied up in the shop for repairs for a longer time than it should be on account of antiquated methods, is simply dead weight, representing a small fortune from which the management receives no returns whatever. Here is invested capital from which there is no dividend at all. But with oxy-acetylene welding in stripping engines and rebuilding them, dead weight of deposited capital will be put into circulation, from which legitimate revenue will be derived.

The next advantage derived from oxy-acetylene welding and cutting process is that heavy boiler and engine repairs can be made in a small locality with meager facilities and a limited shop capacity. In 1911 the Federal Government demanded that common carriers engaged in interstate commerce maintain their locomotive boilers in a safe and suitable condition for service. This demand had to be met. The boiler department received an impetus and a consideration previously unknown. Men had to be employed and tools bought. Many local, and even some general shops, had to be enlarged. The Federal Government, noting the beneficial results which followed, decided that it would be wise and equally beneficial to enlarge the scope of this law so that it would cover the engine and tender, thus making obligatory upon the part of these common carriers to maintain the entire locomotive in the condition described. This demand will have to be met in conjunction with the other. The engine will not be permitted to go into service at the option of the roundhouse foreman, master mechanic, or any other official unless fit for service as per the standard requirements of the Government. Locomotives will not be permitted to run down and go to pieces before shopping. They must be kept up. To do this, it will require live men as foremen. The human element is the first factor to be considered in all advanced moves. The next is advanced methods which will enable the company to perform repairs with great rapidity. Oxy-acetylene welding has proven equally effective in meeting the demands of the engine. This process, properly installed in a shop and efficiently supervised with meager facilities and shop capacity, will prove a mighty factor in meeting the demands of the Federal Government in maintaining the power in serviceable condition, with minimum cost and delay, at the same time localizing the repairs and relieving general shops of their burden.

Another advantage resultant from oxy-acetylene welding is the marvelous savings effected in the reclamation of otherwise scrap material. This is accomplished in many instances without the necessity of removing castings, channel bars, I beams, or plates from the locomotive. To supply a railway system with material, and maintain only a minimum stock, yet having sufficient to meet all demands from all departments, has always been a stupendous undertaking, but never so difficult as at the present time. Heavy power, increased tonnage, steel equipment, and safety appliances of today have created a demand for mate-

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rial little dreamed of in the early days of railroading. Rolling mills, steel and cast iron foundries, and others, have endeavored to meet this demand, but the European conflict has in large measure diverted the stream of supply into other channels, and home consumption, therefore, has been compelled to economize greatly in the material line or do without. Some method by which defective material while in service could be redeemed, or, at least, its life prolonged, and otherwise scrap material reclaimed, has been an absolute necessity. The ingenuity and resourcefulness of the American railroad man has never been so fully and conclusively demonstrated as in this instance. With the oxy-acetylene welding and cutting torch he transforms scrap piles into storehouses of serviceable material, and extends the life of finished and applied equipment 50, 75, and in multiplied instances, to 100 per cent. This is no fancy sketch, neither do I wish to draw on your imagination, but I am relating to you facts culled from practical experience, and am speaking, therefore, from personal knowledge.

Many other advantages are attached to the oxy-acetylene cutting and welding process, but I only wish to mention just one more.

It eliminates the use of a great many tools, reduces the demand for pneumatic hammers and motors and makes it possible to produce high speed lathe tools at a greatly reduced cost. No argument is necessary to prove this, as it is a logical conclusion, for it naturally follows that if a new method of performing work has been developed, that old methods and tool usage have been curtailed in a measure. Now, mind you, oxy-acetylene welding and cutting is not a supplanter or a substitute, but an innovation of mechanical skill and superabounding with economic advantage. The old, which proved good under test, will remain and that which failed to meet the demand is the field which oxy-acetylene welding is trying to enter and strengthen. Thus, as a whole, we march along in victorious triumph and rejoice together over successful achievements, knowing that we have contributed our part to lighten the burden of our fellow toilers, make possible the success of our employers, and assure the public that their interest is our concern; that we are endeavoring with our combined skill, to construct a boiler which will stand the test, an engine which will not fail, an equipment which in service is unsurpassed, and in comfort unequalled in safety beyond a doubt.

The oxy-acetylene process being simple and comparatively inexpensive to install and operate, has found much favor with plants for conserving machinery and material. It makes possible repair jobs never dreamed of a few years ago. The present high prices for raw material, coupled with the inability to get new machinery within a reasonable time, has sent plant owners scurrying for new processes that will help them keep the profits on the right side of the ledger.

An eastern plant that uses many tools, found one day their scrap-pile filled with disabled tools that represented thousands of dollars in lost profits. Reclamation was begun. Workmen were instructed to return all broken tools of whatever character to the storekeeper. The tools were then turned over to a machinist who passed on whether or not it would be profitable to reclaim them. As a rule it was found that by welding or "filling in," repairs could be easily and quickly made at a small cost.

Under the oxy-acetylene process, for example, the combination of oxygen and acetylene produces a heat of 6,300 degrees Fahrenheit, and fuses two pieces of metal, invariably leaving the weld as perfect and strong as the other parts.

The advantage of either the electric or oxy-acetylene processes is that the welding can be done often with the broken parts in place, without dismantling the machine, thus saving valuable time and much extra labor.

An automobile manufacture in a middle western city found there was a big leak in the making of certain castings, through many castings with only minor defects being thrown aside as worthless. These losses were overcome by oxy-acetylene welding, used to fill up slight holes and in building up parts thinned by careless pouring, all at a cost much less than re-melting and re-casting.

One concern manufacturing chain belts was handicapped in delivering a rush order because a careless workman, in the roughing of some very large links preparatory to rounding them, took off too much in the rough cut of a number of pieces of the bar steel. As time would be lost in getting a new shipment of steel the oxy-acetylene process was called into play and in a few hours the ruined links were built up again and made perfect, the order being delivered on time.

Another small firm uses the process in filling up gas blow-holes in castings, as well as taking care of shrinkages and other imperfections. An automobile manufacture rescued a large number of housings for gear shifts which were filled with pin-holes. The holes were filled by adding metal under the oxy-acetylene flame which fused the new metal with the old and made a perfect job. To spoil or damage a nearly completed piece of work costs money and where it can be made over at slight cost means the plugging of another leak.

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It used to take us two years to build a fast destroyer. We have just built one in a little more than two months. These crafts, costing two million dollars each, have the engine power of the old battle ship Maine and the speed of a motor boat. Experience has shown that they are the most effective weapon against the German submarine.

At the outbreak of the war, we undertook to build more of them for the American navy than there had been previously in any two navies of the world. When we succeeded in completing one in eight months instead of two years, the navy threw its hat in the air and cheered. Then, with the speeding up of production, another was completed in six months, and it seemed as if we had done the impossible. Now, in the Mare Island Navy Yard, the destroyer Ward has been launched 17½ days after its keel was laid, and it has been completed in 70 days.

And this is no single miracle. We are not building destroyers. We are manufacturing them. The process by which the Ward was manufactured is a machine process, by which we can produce at the same rate, as many destroyers as we need. The steel parts are prepared, in various plants, all over the country, in accordance with standardized plans. These parts are assembled in navy yards, put together at the docks, swung into position and riveted in place by a force of men working night and day. In other words, standardized destroyers are being turned out as standard automobiles are turned out, in quantity production. And the navy reports that one flotilla of these destroyers, having steamed a million miles on patrol, has protected 86 convoys and 717 single vessels, and fought 81 submarines without any loss to the destroyers or to the vessels which they escorted.

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"I. O. C. Type 4-1000 Unit Generators for Oxygen and Hydrogen" is the title of Catalog No. 4 just issued by the International Oxygen Company, 115 Broadway, New York. This catalog—8½x11, 24 pages—describes and illustrates the latest improved electrolytic oxyhydrogen generator of the Company, gives dimensions and capacities, and presents working plans of two typical plant layouts of common capacity showing the extreme compactness of this new cell

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THE WELDING ENGINEER
608 S. DEARBORN ST., CHICAGO

(Continued from Page 34)

while, on the other hand, for thicknesses of ¾ inch and under one or other of the gas systems is preferable.

The writer has been asked to summarize as briefly as possible the conclusions reached in the very able papers recently read by Commander E. P. Jessop and Naval Constructor H. G. Knox, both of the United States Navy. The full report of these papers has been largely circulated on this side by our leading technical journals, and has no doubt been seen by most of you. The principal welding consisted of the repairing of the cylinders of some eighteen German vessels, where large pieces had been broken from the upper portions. The method of a repair consisted of the welding in by the electric arc or oxy-acetylene gas of a new piece in cast steel or cast iron to replace the portion broken away. In arc welding the old and useful device of tapping short steel studs into the cast iron was used to enable the added steel (in this case) to make a surer weld. The electric arc welding repairs were carried out with the cylinders in place, while with the oxy-acetylene process it was necessary to remove the cylinders so that the joints for welding could be laid in a horizontal position, and also that the cylinders could be heated. Commander Jessop quite truly points out that the great difficulty found in the arc welding of the cast iron surface was to get the first layer of the adding steel material to adhere and that this layer was always added before the patch was put in position for welding. In the oxy-acetylene jobs, as before remarked, the cylinders were secured in place, and, the joints being horizontal, both sides of the joint were made fluid, and cast iron sticks melted into the bath thus formed. Both methods appear to have given excellent results, and the repairs are certainly the largest of their nature that have yet been carried out, and reflect the greatest credit on all concerned. It would not be wise, however, to generalize on the treatment of cast iron from these results. You will remember that we have before remarked that with good mixtures of cast iron, one can, with fair certainty, make a good weld. It must be remembered that these were high class vessels, and that in all probability the very best metal would be used in their cylinders and liners, and certainly in superheater jobs the high pressure cylinders and liners would be of a very special mixture, which so far as the writer's knowledge is concerned has only been made in this country during the last five or six years. The writer trusts that we hear further on this point, but his present information is that these vessels were superheater jobs.

The writer claims that arc welding, where carried out by skilled operators with suitable materials, is absolutely reliable, and can point to some 20,000 jobs, some of a very big nature, while the percentage of even partial failures would, at any rate, be on the right side of the decimal point. These partial failures would be mainly accounted for where the work was carried out under unfavorable conditions, and often in the nature of a forlorn hope. Great difficulties are met with in hurried repairs to the lower portions of the hulls of vessels in dry dock, where water is constantly dripping from the leaky portion, and owing to the cement inside it is often impossible to stop it in the time available. It must, however, be remembered that metal added by the heat of the electric arc or other methods has not been subjected to the same amount of work as a rolled steel plate or forging. It is, therefore, not so well adapted to take up work suddenly applied, and one would not recommend it for a position of responsibility where such conditions arise. This, however, is a condition generally recognized by engineers with all welds.

BINGHAM COMPANY ACQUIRES COLLOONEY

Sir John Barran, having asked the Parliamentary Secretary to the Minister of Munitions whether he was aware that users of acetylene, both public and private, had, owing to the prohibition of the sale of carbide for many months past, been placed in greater difficulties than the users of any other kind of artificial light; whether the dealers in this country had considerable stocks which might be distributed in whole or in part without touching the supplies on which the State depended for munition purposes; and whether the present position as regards stocks was such as to warrant allowing at any rate a mall release to public and private user without risk to national reserves. Mr. Kellaway replied that the position of carbide supplies had recently improved and he was considering the possibility of releasing a certain quantity for purposes (including those of public and private buildings and vehicles) which had not hitherto been permissible. The available stocks did not, however, justify the release of more than a small proportion of the amount used for those purposes

AMERICAN FOUNDRYMEN'S CONVENTION

The American Foundrymen's Association held a very successful convention in Milwaukee the week of October 7th to 11th. probably more manufacturers of oxy-acetylene welding and cutting equipment exhibited than have ever exhibited before at any gathering. Among the exhibitors were the following:

Bastian-Blessing Co., Oxweld Acetylene Co., Torchweld Equipment Co., Davis-Bournonville Co., The Prest-o-Lite Co., Inc., The Alexander Milburn Co., Imperial Brass Mfg. Co., Air Reduction Sales Co., McLeod Mfg. Co. Torches manufactured by the Harris Calorific Co. were also exhibited in connection with safety devices. The Hauck Mfg. Co. also demonstrated their lines of well known preheating torches, as did also the Mahr Mfg. Co. Exhibitors report an unusual interest among those in attendance in welding and cutting apparatus.

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The General Welding & Equipment Co., 107 Massachusetts Ave., Boston, have issued a new booklet describing various cutting and welding torches, regulators, etc. The construction of torches is described in detail.

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By S. W. MILLER

287 Pages, 6 x 9 Inches, 192 Illustrations

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Ten years ago the oxy-acetylene method of welding and cutting metals was hardly more than a laboratory process, but in the course of these few years it has become one of the most important of the methods in the metal-working industries. Much has been published relating to this process, but a great deal of that which has been placed on record in the past has been descriptive of odd jobs. It is, therefore, believed that the present volume, dealing in a more systematic manner with the principles and practice of the art of oxy-acetylene welding, will be of considerable value to those engaged in the metal trades.

The information here presented on the subjects of oxy acetylene welding and cutting has been mainly furnished by S. W. Miller, proprietor of the Rochester Welding Works, whose wide experience in the practical application of the process, and whose success in the work, vouch for the reliability of the information here placed on record. The experience of the author in the oxy-acetylene welding field has been unusually extensive, but having been mostly on repair work, he has written especially for those engaged in a similar line. A great deal of the work done with the oxy-acetylene welding torch is on repairs, and while there are also a great many applications of it in manufacturing work, such applications are more or less special in each case, and sometimes require a great deal of experimenting before success is attained. The general principles here presented, however, apply equally to repair and manufacturing work. This volume describes the equipment required for oxy-acetylene welding and cutting, deals in detail with methods used in welding cast iron, malleable iron, steel, copper, brass, bronze, and aluminum and gives in addition, special attention to the welding of sheet metal, tank welding, boiler repairs, etc., as well as to the subject of lead burning, which is a special kind of autogenous welding.

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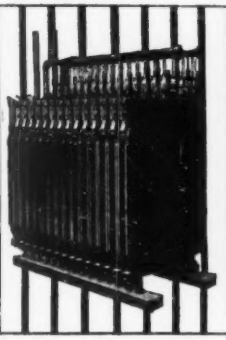

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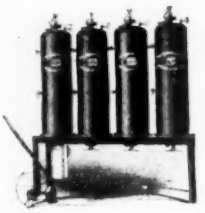
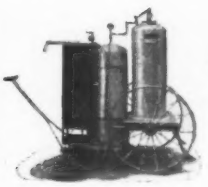
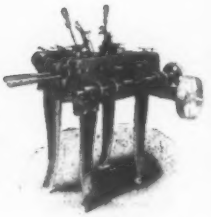
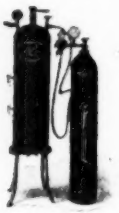

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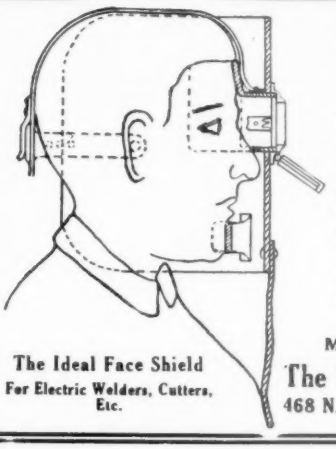

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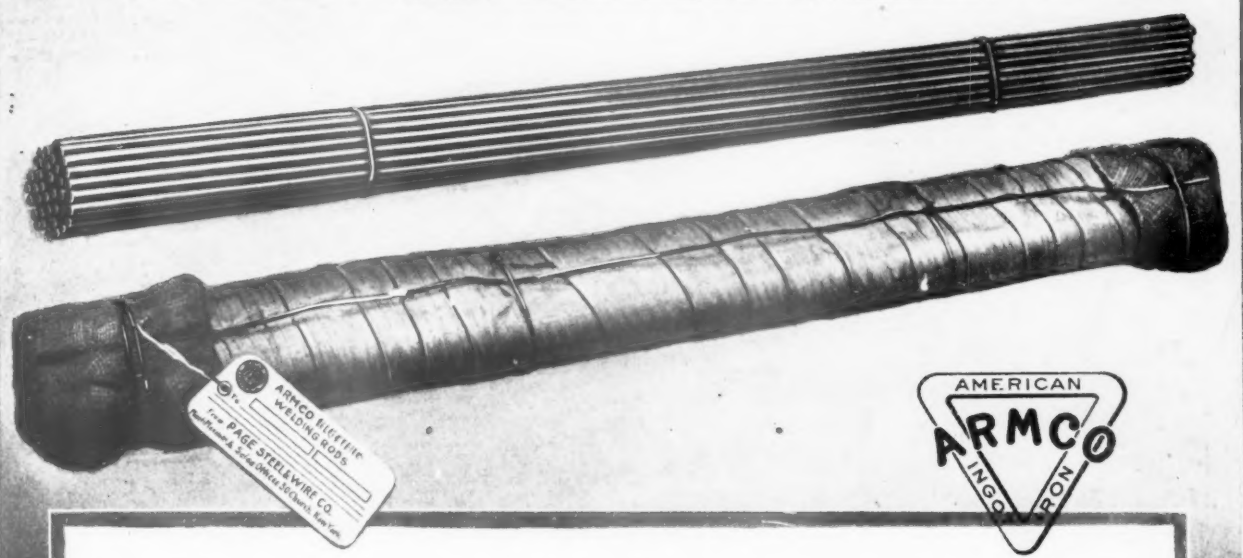

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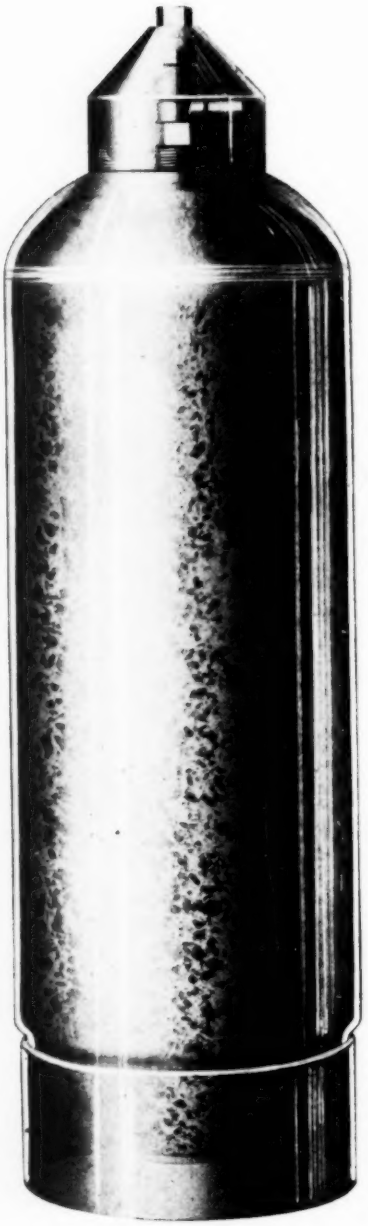

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